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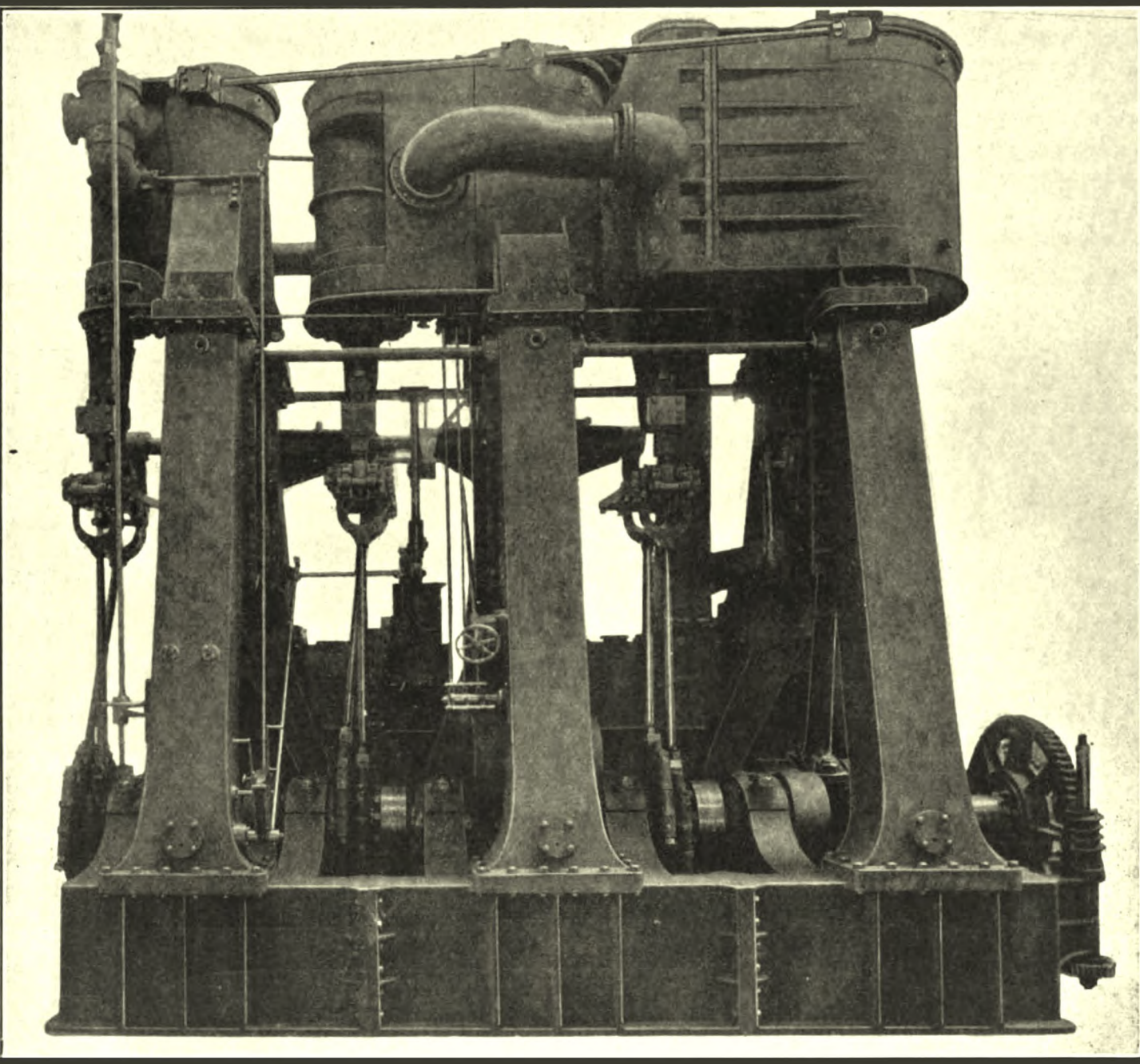

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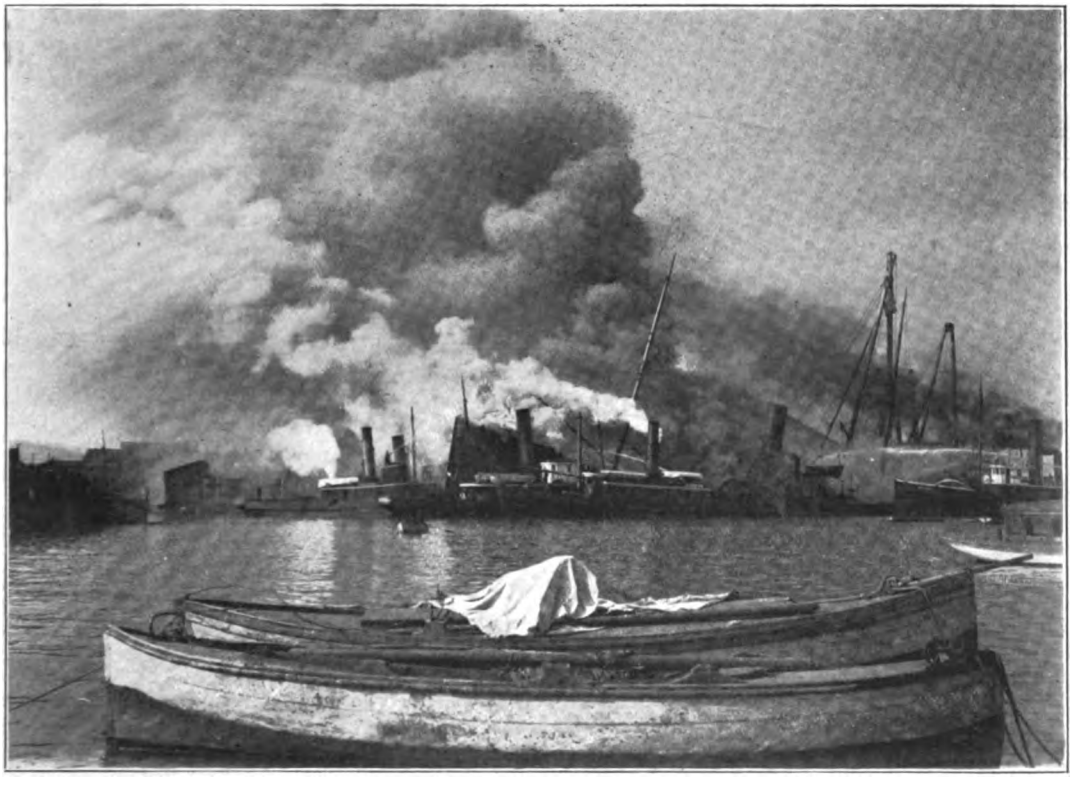
EXPLOSION ON OIL-TANK STEAMER PROGRESSO.

On the morning of December 4 the steamer *Progresso* was lying at the wharf of the Fulton Engineering and Shipbuilding Works, San Francisco, where she had been for about six months while being converted from a coal-burning coal carrier into an oil-burning oil carrier. The repairs, which were nearing completion, included an installation of new boilers and engines, and a thorough overhauling to equip her to ply in the oil-carrying trade between Philadelphia and Texas ports. Men were at work putting the finishing touches on the new cargo tanks, while the engine- and boiler-room force were getting the new burners into operation preparatory to running the trial trip the day following. The steam on the boilers had reached between 30 and 40 pounds. The only oil on board was about 400 barrels in the fuel-oil tank, which was built to carry 1,940 barrels.

Without an instant of warning a violent explosion broke the steamer squarely in two, forced up the deck amidships, and tore and twisted the steel plates of the hull as though they were made of tin. Within a few minutes the ship was enveloped in dense clouds of black smoke that soon burst into flame, while burning oil ran out of the hull and blazed up on the surface of the water for a considerable distance on all sides. Fourteen men were killed outright and about the same number found their way to various hospitals. The scenes that followed the explosion were heartrending in the extreme. The ship was moored eight or ten feet from the wharf of the works, just under the shear legs. Many of those that made their escape covered the distance from the deck to the dock by blinded leaps, while others slid down ropes or sprang into the water to be immediately surrounded by the burning oil. Several of those killed were blown from the ship's hull out into the water and their bodies eventually recovered 100 feet or so from the ship's side.



THE OIL TANK STEAMER PROGRESSO BURNING AT THE DOCK, SAN FRANCISCO.

The plant of the Fulton Engineering Works is located

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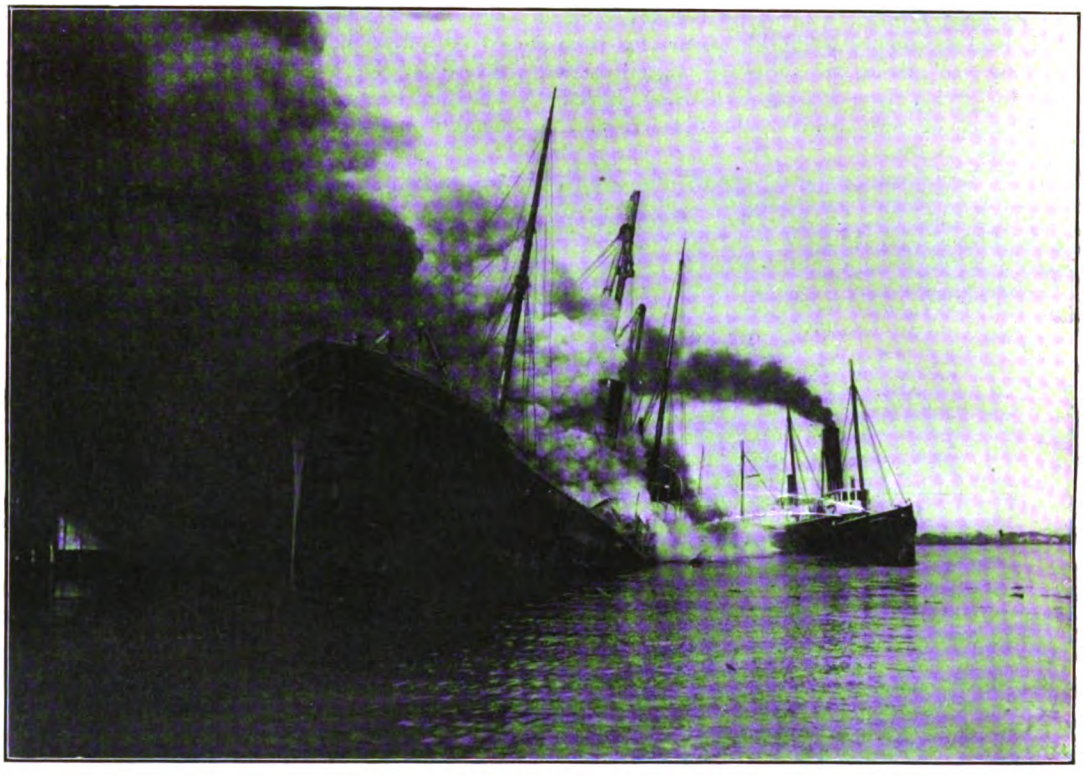
near the far-famed Presidio, and at the time of the explosion the field battery of the First Artillery, as well as several other detachments of soldiers, were engaged in regular morning drill. They were immediately ordered to the scene and were the first to drag the injured away from their perilous positions, and saved the ship's papers, as well as other effects that could be carried off. They policed the works and held sway until the later arrival of the police and fire departments of the city, who had been called on general alarm, but were unable to reach such an out-of-the-way place in good time. Regardless of tons of water that were poured into the hull all day long, the big tank steamer became a seething, roaring furnace, and for a time threatened the safety of the wharf and of the iron works. The fire had to burn itself out. The following day, when it was possible to make an examination, it was found that the ship was a total loss, the disaster involving between $200,000 and $250,000.



FIRE BOATS AT THE BURNING OF THE TANK STEAMER PROGRESSO.

From the illustration of the tank arrangement, shown herewith, it will be seen that there were five *cargo* oil tanks and one *fuel* oil tank. These were separated from the boiler and engine-room space by a water cofferdam three feet thick fore and aft, as well as ten feet of air space. As noted before, the only oil on board consisted of about 400 barrels in the fuel-oil tank. The only outlet to this tank was to the deck above, and this was covered by a manhole plate, which was blown by the explosion forward amongst the rest of the débris.

In the incipient experiences with a new fuel more or less trouble may be expected. But crude petroleum, like the heavy oils of the Kern river field, has been used by the Baku oil carriers on the Black Sea for twenty years or more, and we have yet to learn of the first accident occurring to any of that fleet. There are 250 manufacturing plants in San Francisco and over 100 vessels sailing from that port using crude petroleum with equal security. The various investigations that have been started by those interested in this matter promise to divulge many things about fuel oil which are not yet a matter of record, and they may or may not determine the cause of this explosion. So far it remains as complete a mystery as the day it occurred.

Nearly all cities where crude petroleum is used for a fuel have an ordinance providing that no oil may be used or exposed for sale if it flashes below a prescribed minimum temperature. The lowest temperature fixed in any State or municipality is 110 degrees Fahrenheit, and this temperature was accepted by the Board of Supervisors of San Francisco when they provided that,—

"No crude petroleum or any of its products, or any oils or fluids, shall be used for fuel, cooking, heating, or illuminating purposes within the city and county of San Francisco, unless that same will stand a fire test of 110 degrees Fahrenheit, or better, before it will flash or emit an inflammable vapor. No person or persons, firm, company, or corporation shall ***mix, adulterate,*** or offer for sale any oils used for heating or illuminating purposes, with benzine, naphtha, gasoline, or any other substance; and all oils or fluids manufactured from petroleum or any of its products, to be used for heating

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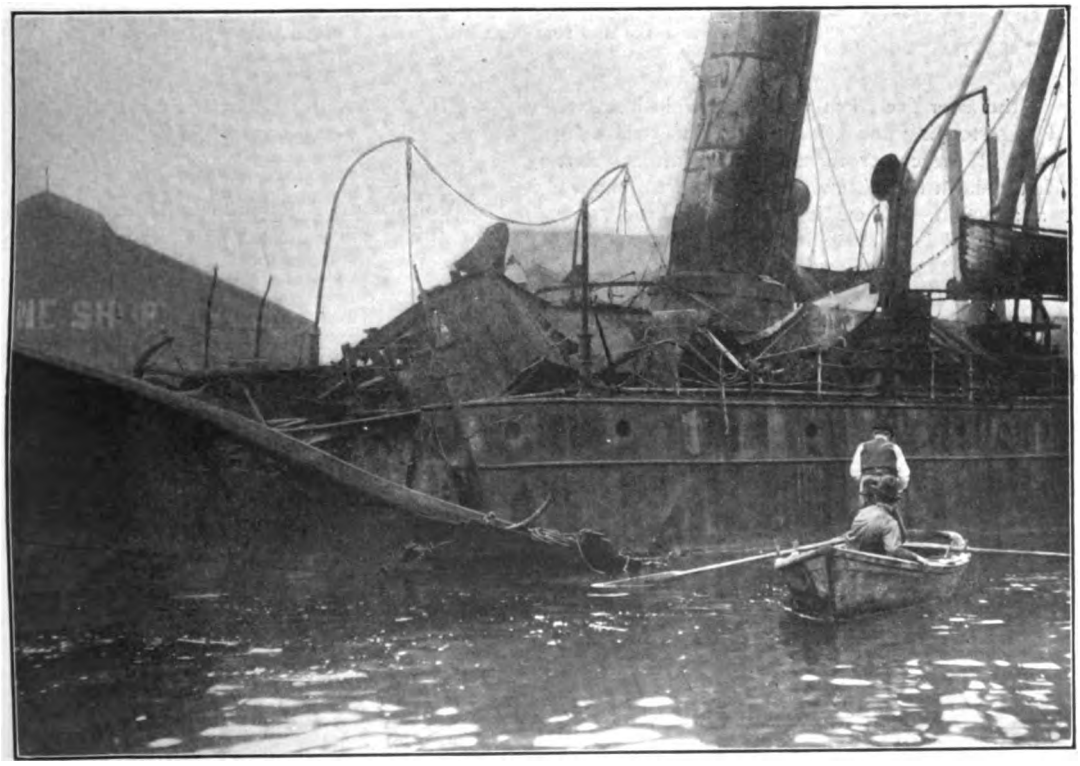
PORT SIDE OF THE PROGRESSO, BLOWN OUT BY THE EXPLOSION.



THE WRECKED PROGRESSO. THE MEN IN THE BOAT ARE DRAGGING FOR BODIES.

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or illuminating purposes, shall be required to stand a fire test of 110 degrees Fahrenheit, or better, before it shall flash or emit an inflammable vapor."

The owners of the ill-fated *Progresso* secured permission from the Secretary of the Treasury of the United States to burn oil upon submitting a plan of the vessel for his inspection. The law governing the granting of such a permit is as follows:

"The Secretary of the Treasury may permit the use of petroleum as fuel on steamers not carrying passengers, without the certificate of the supervising inspector of the district where the vessel is to be used, subject to such conditions and safeguards as the Secretary of the Treasury, in his judgment, may provide."

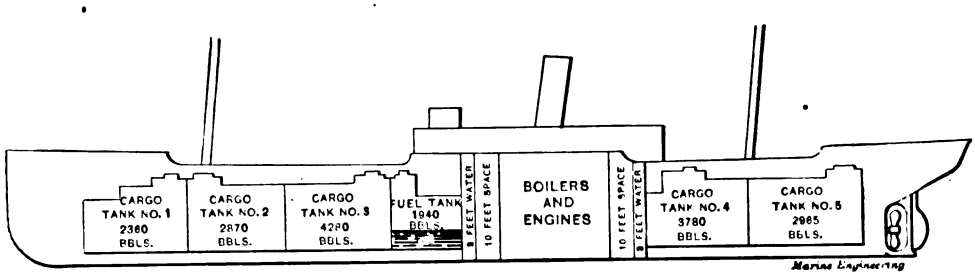
Though not compulsory, as shown by the law cited, it is understood that the owners of the *Progresso* submitted their plans to the supervising inspector of the district and secured his approval, as well as that of the Secretary of the Treasury.

It may be interesting to note the experience of one of the men who were below at the time of the explosion, and who is credited with a most miraculous escape. He says: "—— and myself were the only persons in the after fire room when the explosion took place. I was stooping down, looking up under the ash-pan damper of the center furnace of the after boiler, when I felt a shock that threw me forward and stunned me for a moment. I knew it was an explosion, but was not sure until later as to just what had happened. I can say, positively, that the cause of the explosion did not lie in the oil burners, which were working splendidly. We did not see any one as we left the after fire room, and I think there was no one else in that particular portion of the ship. It was a hard struggle for us to reach the upper deck because of the dense smoke and the darkness that enshrouded everything. We climbed up some sort of a companionway in the dark and from there made our way around the boilers and on up until we could see the light. It was a severe test on our endurance, for at every step we were breathing the heavy gas-laden air."

The *Progresso*, formerly the *Wells City*, was built at Sunderland, England, in 1885. Her dimensions were: length, 270 feet; beam, 36 feet; and depth, 23.5 feet. She had a gross tonnage of 1,919 and a net tonnage of 1,445. After her transfer to the American flag she was registered in New York under her new name. She was formerly owned by the Progresso Steamship Company, and was valued at about $200,000.

The problem that confronts the Fulton Engineering Works is the removal of the mass of wreckage which occupies the most important part of the shipyard frontage. It is thought that it will be possible to erect temporary bulkheads for each half of the ship, and, after cutting away the portion remaining between these two divisions, float each section independently of the other.

Steamer Monroe.—The Newport News Shipbuilding and Dry-dock Company, Newport News, Va., launched on October 18 the passenger and freight steamer *Monroe*, which is intended for the New York and Norfolk service of the Old Dominion Steamship Company. The dimensions of the vessel are as follows: Length over all, 366 feet; between perpendiculars, 344 feet; beam, molded, 46 feet; depth, molded, 37 feet; draft, 18 feet; displacement, 5,375 tons. Accommodations are furnished for 122 first-class passengers (white), 22 first-class passengers (colored), 78 steerage passengers, 57 deck passengers, and officers and crew of 81. The vessel will be driven at a speed of fifteen knots by a vertical triple-expansion engine of about 4,500 I.H.P.



ARRANGEMENT OF CARGO AND FUEL-OIL TANKS, STEAMER PROGRESSO.

MEMORANDA REGARDING FUEL OIL ABOARD SHIP.

BY WALTER J. GOODENOUGH.

It is hoped by the writer that the remarks contained in this article will be taken largely as suggestions, and that others interested in fuel oil for marine purposes will take occasion to criticise them through the columns of MARINE ENGINEERING, in the desire that much fruitful discussion will ensue, such discussion at the present time being of considerable benefit to vessel interests.

At the moment this subject is of much importance to shipbuilders and shipowners. Not so much because of the advantages of cheap fuel for certain localities, but because of the sudden desire and intention of placing upon vessels a new and somewhat untried device. This carries with it the dangers resulting from all such arrangements; and to minimize these dangers and afford a basis for insurance, Lloyds have in a circular letter to their surveyors conveyed certain directions regarding the installation of bunker tanks and burning apparatus in vessels which have previously been used otherwise than for the carrying or burning of oil. Lloyds' letter, then, becomes one recognition of the seriousness of the problem, and is all the more significant owing to the vast interests which they represent and protect. The Bureau Veritas has long recognized that oil-tank steam-

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ers form a class by themselves, and that they require special rules for their construction. They began first to give these vessels their attention and assistance at a very early period, and have continuously aided owners, underwriters, and shipbuilders in their efforts to obtain safe, insurable vessels. To meet the increasing business of this kind in the United States, where most of the "lines" on oil cargoes are carried, the United States Standard Steamship Owners', Builders', and Underwriters' Association, Ltd., is preparing a set of rules for the construction of oil-tank vessels and their machinery. It is expected that these rules, which are to be very complete in character, will appear shortly.

BUNKERS.

The position of the fuel-oil bunkers is a first problem of design. It has been the practice in some vessels to use the double bottom and peak tanks for the storage of oil, even in vessels where the cargo is oil in bulk. While this practice is in many cases necessary, it must be pointed out that it entails a considerable danger owing to the extremely confined spaces and to the original light riveting and construction employed. In the ordinary construction of vessels it is usual to slight such portions of the work as are inconvenient to get at by the workman, and it is just in these places (water bottom and peaks) where the slighting is the greatest. When oil is placed in such compartments it speedily shows that the makeshifts for procuring water-tightness are of no avail. Again, adequate examination and cleaning of these tanks is extremely dangerous to life and to property. The heavy gases confined in small, close spaces, prevented by the nature of the construction of the vessels from circulating freely, stand ready to suffocate the luckless surveyor or cleaner, or to destroy the vessel in an instant should a spark be present.

Supposing, however, double bottoms and peak tanks to be the only places available for the storage of fuel oil, its storage should not be countenanced in tanks in way of the fire and engine rooms. This does not agree with Lloyds' letter where it states: "Arrangements for carrying astaki oil fuel in cofferdam between the boiler space and the petroleum tanks, in double bottoms, and in the fore and after peak tanks have been approved." I believe, however, that it is the opinion of the men who have to inspect these vessels that the danger is too excessive to be permitted to stand. Imagine a vessel striking an obstruction in way of boiler room double bottom, forcing up floors and opening seams of tank top, permitting the oil, buoyed up by the water pressure due to vessel's draft, to enter the fire room, generate gas and ignite the same. This might easily be the occurrence where the damage due to grounding was merely insignificant. In the same way consider the tanks at the sides of the boilers, and that the vessel receives some of the ordinary blows given in warping to dock or by lighters.

The practice of carrying oil in the cofferdam would seem without logic. We might as well say immediately that oil will prevent oil from entering the fire room in the case of leakage.

It may be said that the question of whether the shipbuilder and the shipowner make money or not will depend largely upon the excellence of workmanship in the construction of tanks. The requirements for testing such tanks are rightly severe, and the cost of correcting defects in this class of vessel is much greater in proportion than for ordinary ships. In oil-tight work the makeshifts of felting and red lead are only temporary in their assistance, and in the places where it is customary to use them it is most difficult and expensive to repair the damage when they have given way. The value of rigid testing should not be under-estimated, as the heaviest static pressure tests now used are far from representing the forces hurled against shell, deck, and bulkhead when the vessel is in a seaway and the cargo and the oil of the partly-filled bunkers exert the force due to their inertia.

A desirable form of bunker is one of large capacity, narrow in proportion to its height, offering thereby the least free surface and affording such a quantity of oil that suctions do not require to be changed often; of such depth that the entrance to the suction can be well above the bottom of bunker, insuring greater freedom from dirt and water. All bunker tanks should have easy means of access for the inevitable and frequent cleaning. It is also apparent that all bunkers, where possible, should be built into the ship. To place separate bunkers in a vessel is to create spaces between them and the hull for the collection of gases, and to prevent obtaining in the fullest degree proper and adequate ventilation.

VENTILATION.

The ventilation of all confined spaces, in tanks or outside, where gases may collect, is by no means as easy as it appears. These gases are heavy. To put a ventilator to the top of the compartment and there stop is simply to change the air immediately above the stratum of gas, and that stratum gradually becomes thicker as the oil recedes, leaving the wetted surfaces and volume of gas to increase. To carry the ventilator nearer the bottom of the space is to stir the gas by the inrush of air, but the gas will not depart, because it is heavy, and as the tank is air-tight it would produce a vacuum should the gas endeavor to get out by the one ventilator. A current must be established. There should be an inlet at the top to supply air, and an outlet somewhat lower to remove the mixture of air and gas. As the direction of air currents in a ship is invariably from aft forward, the inlet will be aft and the outlet forward. To assist further, the inlet will be a cowl ventilator, and the outlet an induction ventilator. Complicated and expensive as such a system appears, yet, properly installed, it does its work without attention or repair until the vessel has ceased her service. The tops of all ventilators should be carried well up into the air and away from close proximity to house or other deck erections. No oil-tight tank should be permitted to be without means for allowing air to enter at any time. Lack of such provisions has been known to bring down decks or spring bulkheads.

Electric-driven fans used for clearing holds of gases should have the motors carefully isolated in a tight compartment where there is no possibility of gas entering to be ignited by a spark from the commutator.

It has been often suggested that plugs or manhole plates should be fitted in the bottom of oil compartments for the escape of gas. While it can undoubtedly be safely and securely done, yet the times when such devices can be used are the infrequent times when the vessel is in

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dry-dock; so that the ship would derive, in the ordinary course of running, but little benefit.

PIPING.

As in the construction of oil work, the piping requires the acme of careful fitting. As near as possible, when screwed joints are used in the suction and deliveries of oil pumps, the work should be a metal-to-metal fit. Where any jointing is used at all, it should be allowed to remain undisturbed until it is very hard, otherwise the oil washes it away from the joint. A very good pipe cement for oil work is made of litharge and glycerine, also a mixture of Venetian red and shellac. The use of rubber or compositions containing rubber for flange jointing is not good practice, owing to the very rapid deterioration of such materials in contact with petroleum.

Before any pipe carrying oil to burners is put up it should be carefully hammered to loosen all scale and dirt on the inside of the pipe. As nearly every form of burner has a very small orifice for the oil, they are easily clogged, which necessitates taking the burner apart. This operation reduces temporarily the amount of steam evaporated by the boilers, and amounts in some instances to throwing one furnace out of commission.

In laying the suction pipes, care should be taken that, under any ordinary list or trim of the vessel, gas pockets be not formed at high points in the pipe. Should a thoroughly good gas pocket be obtained, it will be very hard to overcome, and in the meantime the effect will have been felt at the burners and on the boilers. A sudden decrease in the amount of oil, without the same decrease of air, means an excess of cold air and a cooling of the boiler.

Any crude oil has a large amount of foreign matter in the form of dirt, sticks, bits of waste, etc. It is to be recommended that no suction-pipe to fuel-oil pumps be fitted with a rose or strainer in the tank, but that approved strainers in duplicate, with by-pass to both, be fitted near the pump. This arrangement always leaves one to be cleaned while the other is in operation. The placing of strainers in the tanks is undesirable, as it leaves the engineer powerless in case they become stopped up, because he cannot enter that tank to make repairs while it contains oil. It is a nice precaution, however, to have all suction lines so arranged that they may be blown through into the tanks by an oil or water pressure.

The practice of running delivery pipes under the fireroom floor to the burners has little to recommend it. Oil-pressure pipes are specially subject to leakage, and were better placed above the floors, where they can be properly looked after. The necessity of keeping pipes clear of coal and ashes is gone when oil is burned, and there is, therefore, no good reason for putting pipes in the bilge.

ELECTRIC LIGHT.

The same care is to be taken in the wiring of the vessel to prevent ignition of gases by sparks, as is taken in other directions. Wiring on the two-wire system; careful insulation, and insulation not affected by petroleum; care in location of switches, junction boxes, and cut-outs; and outside air-tight globes over lights, are some of the more important points to be secured.

FURNACE CONSTRUCTION.

Heat is the result of combustion of any fuel; its intensity is due to the rate, and how, when, and where air is admitted into the combustion chamber. Its condition when admitted governs the possibility of its effective mixture with the oil vapor and its complete combustion. It too often happens that complete combustion is impaired, not from the lack of air, but on account of the method of its introduction into the furnace. Any effort, then, on the part of the operator to increase the rate of combustion results in smoke, without raising the temperature of the furnace gases, notwithstanding the fact that there may be introduced many cubic feet of air in excess of that necessary for perfect combustion. For each and every atom of air thus admitted into the combustion chamber in excess of the actual requirements, there must also be introduced a sufficient amount of oil to raise the excess air to the temperature of the furnace before any heat is given off. Excess air results in a waste of fuel and a loss in economy. If more air is supplied during the time that a pound of fuel is burned, the excess must pass through the furnace without performing any service, and in its escape to the chimney carries away 0.2375 of a heat unit for each pound raised one degree in temperature. Therefore, for economic reasons, no more air should be supplied than is necessary.

During the early stages of combustion of any fuel the gases of a highly volatile nature distil at a low temperature, rise rapidly, hug the boiler, enter the tubes or flues, and pass out through the breeching unconsumed. The combustion chamber of the boiler should, therefore, be arranged with firebrick, so that the incoming air may be heated to the required temperature, that the flames may be retarded, diffused, and distributed, and their velocity impeded. Then there will be no concentration or localization, and the danger of burning or blistering any part of the boiler is avoided. Therefore, the statement is not unreasonable *that a scientifically-arranged combustion chamber, with a shovel to feed the oil, is far more to be preferred than a poorly-constructed furnace to which is attached the highest type of atomizing device.*

Thus the matter of furnace design becomes one for the engineer, and not the inventor, and each furnace of a type must have consideration separate from any other one. The great difficulty to be overcome in a Scotch boiler burning oil is to secure a large enough volume in the furnace to properly mix the air with the vapor of oil and thoroughly complete combustion. For this reason it is advisable, in order to obtain the full benefit from the fuel, to remove all grate bars and provide means of utilizing the entire furnace volume.

When using steam or compressed air as an atomizing agent, it is usually desirable to cover the back plate of the combustion chamber with firebrick. The velocity of the issuing steam or heavy-pressure air is so great that in our comparatively short Scotch boilers it would throw the flame heavily against the metal, cooling the flame, reducing combustion, and overheating the plate. In all cases, however, the riveted seams at the rear of the furnaces should be covered with a refractory material, and the furnace shell above the bridge should be covered with firebrick to prevent any direct impinging upon the metal, and to assist in the combustion by heating the air and gases.

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FUEL-OIL TUGBOAT SEA ROVER.

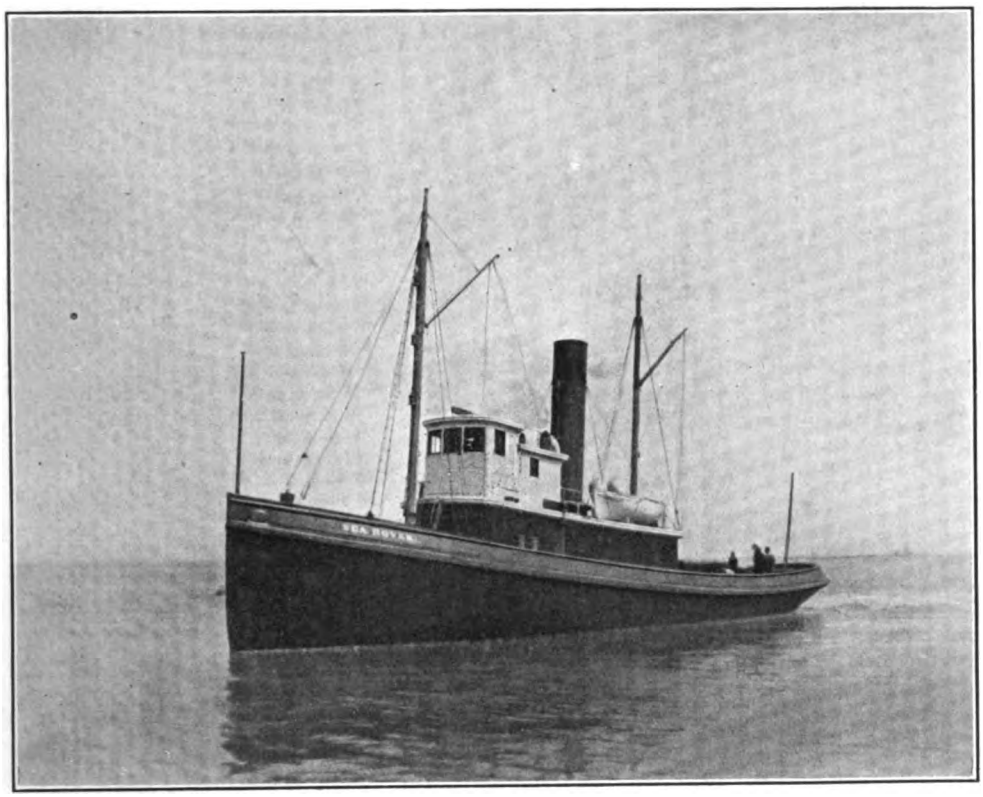
The ocean-going steel tug *Sea Rover* has recently been added to the fleet of the Ship Owners' and Merchants' Tugboat Company, of San Francisco. She was built and engined by the Fulton Engineering Works, at Harbor View, San Francisco, and is of dimensions given in the data table on page 10.

The boat was originally planned as a coal burner, with side bunkers and large thwartship bunkers forward of the boiler room and between the engine and boiler rooms; but the general introduction of oil fuel on the Pacific coast caused the owners to have the plans modified and provision made for carrying the greatest amount of fuel oil. The oil is carried in four compartments, as is shown on the general plan, and each tank, except the fore peak, has a center line bulkhead and other swash bulkheads to insure strength and stability. The oil tanks have a total capacity of 53,400 gallons, which will give twenty days' steaming at full power.

The transverse oil-tight bulkheads consist of 3-8 and 5-16-inch plating, with both vertical and horizontal stiffeners connected to shell and deck plating with plate brackets. All seams and butts are lapped and double-riveted, and a single double-riveted bounding angle connects bulkhead to shell and deck plating.

The deck house is built of steel and contains the usual accommodations of sea-going tugs. The partitions are mostly of light steel plate covered with cork paint. The captain's room and pilot house are built of Oregon pine, with oak finish inside. The main tow bitts are of cast iron and are located between the deck house and the hood or skylight over the main engine, thus placing them well forward and in a fine position for towing. The top of the skylight over the main engine is built in four sections, bolted together, and has four hinges on the forward end by which it may be lifted as a whole when necessary to overhaul the engine, or any section may be removed as required.

There is a large forecastle forward below the main deck for the crew, with store room and chain lockers below. A fore-and-aft bulkhead on each side of the boiler extends the full length of the boiler-room space, thus forming two side bunkers, the after ends of which are used for fresh-water tanks. The air compressor is placed in the starboard bunker, and the port bunker is used as a store room.



TUGBOAT SEA ROVER, FITTED FOR BURNING OIL.

MACHINERY.

The main engine is of the vertical, inverted-cylinder, compound, marine type, built for a working pressure of 175 pounds per square inch. Other dimensions will be found in table. There are three steel front columns and two cast-iron back columns of box section, resting on the condenser, which thus forms part of the framing.

A steam piston valve is on the high-pressure cylinder, taking steam inside, and a double-ported slide valve is on the low-pressure, both steam chests being outside their respective cylinders and connected by a copper receiver pipe. The crosshead is of the locomotive type, with cast-iron guides of box section, cored out for water circulation. The crosshead slippers are of bronze with babbitted faces.

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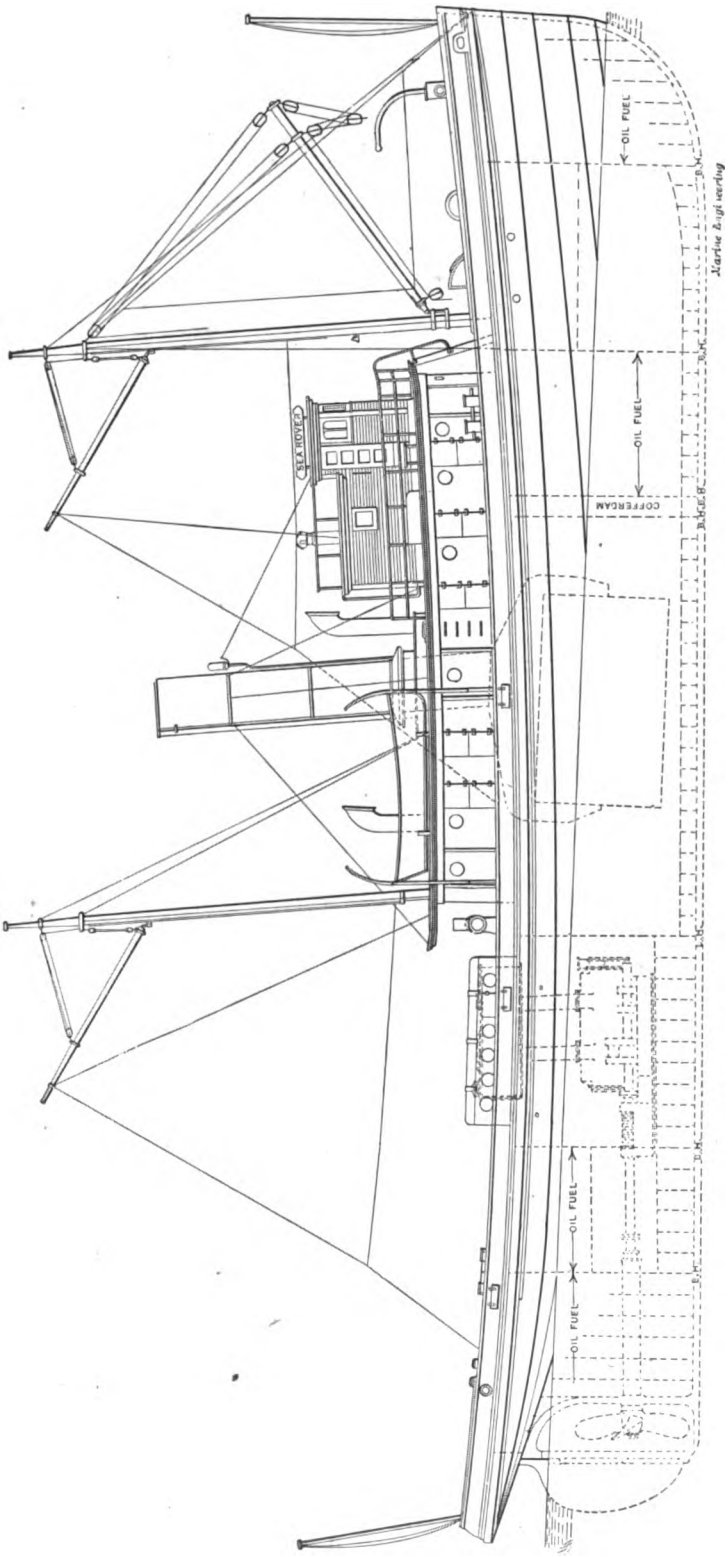

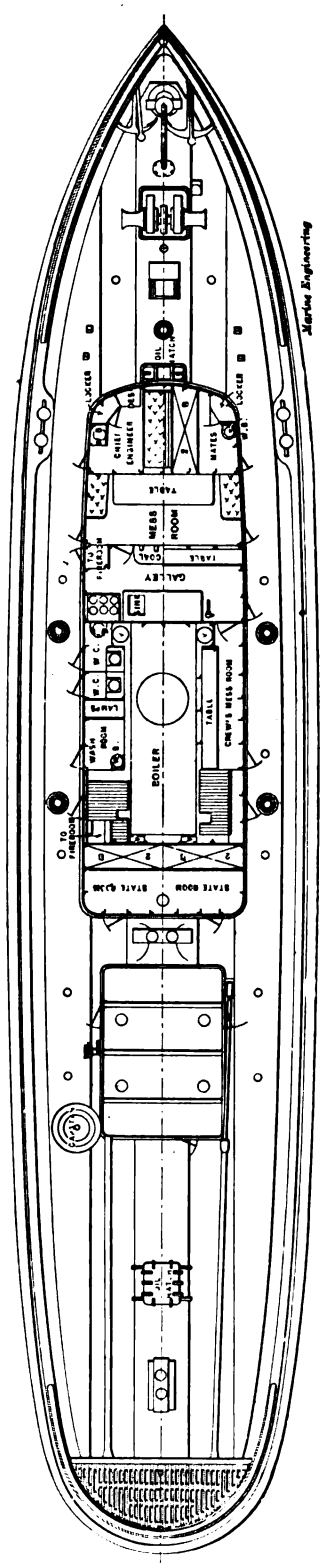

SAIL AND DECK PLANS OF THE OIL-BURNING TUGBOAT SEA ROVER, BUILT BY THE FULTON ENGINEERING COMPANY, SAN FRANCISCO, CAL.

Dished bull ring pistons are fitted, with steel piston rods secured in piston heads with taper and nut. The connecting rod is 70 inches long, with forked upper end and crosshead pin shrunk in, making the bearing in the crosshead. The lower end of the connecting rod is provided with Scotch brasses for the crank pins.

The reversing gear consists of the regular Stephenson link motion, with double-bar links and bronze block, operated by a steam cylinder secured to front of

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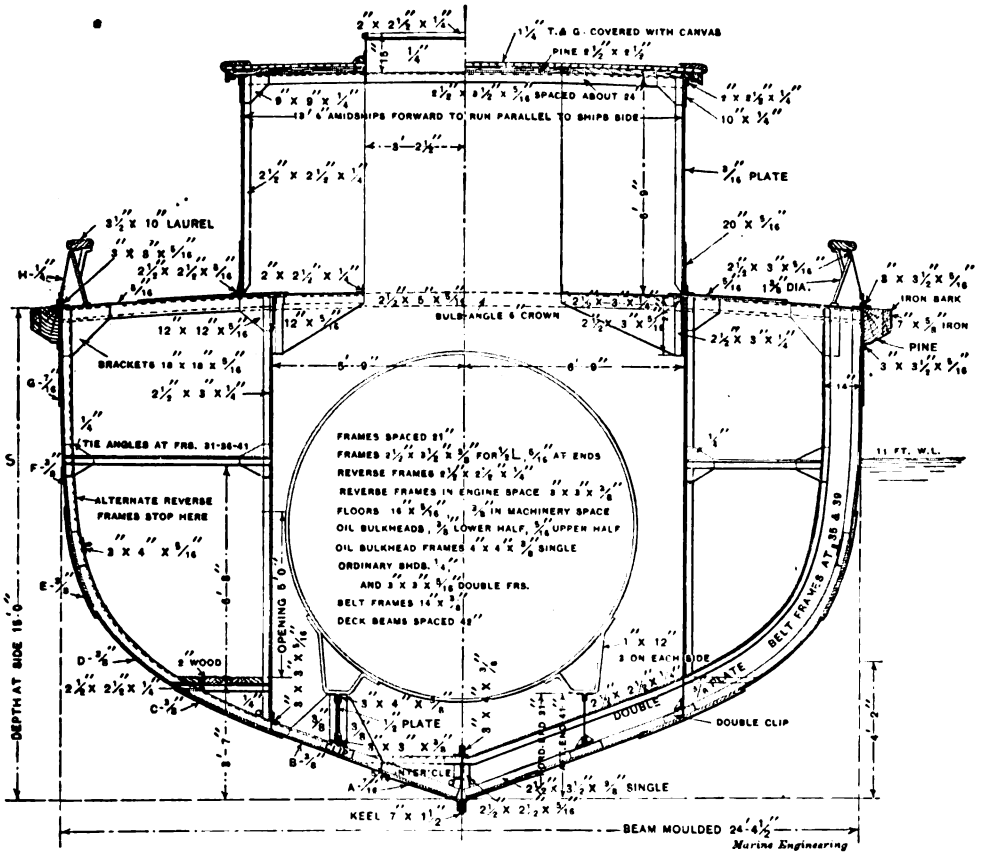
main engine cylinders and connected directly to a lever on the reversing shaft below.

The crank shaft is of the built-up type, with cast-steel crank cheeks counterbalanced. Crank, thrust, and propeller shaft are each 9 inches diameter, the thrust shaft having seven collars forged on same for the thrust yokes, and the propeller shaft being provided with heavy composition liners where it rests in the stern and inboard bearings. The stern tube is of cast iron; the bearings at each end are of lignum vitæ, fitted into brass shells, which are fitted in the stern tube on a taper, to be readily removed when necessary. The propeller is of cast iron, with four blades.

A complete oil-burning plant is also installed, which will be described in detail later in this article.

Steam is supplied by one double-end Scotch marine boiler 10 feet 6 inches diameter by 16 feet 6 inches long, containing 384 3-inch tubes and four furnaces 36 inches diameter inside corrugations. The heating surface, computed on the basis of a coal burner and allowing dead space in furnace and combustion chamber, is 2,213 square feet. The boiler is built to comply with both Lloyds' and the United States rules. When oil is used as fuel and no grates or bridge walls placed in furnaces, the actual heating surface is much larger than ordinarily considered for coal fuel; for this, as



MIDSHIP SECTION OF TUGBOAT SEA ROVER.

There are two feed pumps and one bilge pump, all worked with the air pump by beam from the low-pressure crosshead. The two feed pumps draw from the hot well direct and discharge to the main boiler.

There is a 6 by 6-inch engine direct connected to an 8-inch centrifugal pump; a 6 by 8-inch windlass forward, and a 5 by 7-inch steam capstan aft. The steam steering gear, as well as the above-mentioned auxiliaries, was designed and built by the Fulton Engineering Works, and consists of a 4 by 5-inch double-cylinder engine secured to the bulkhead in engine room, operated by the usual wheel in pilot house, the change from the steam gear to the hand gear being made by clutch levers in engine room. The fire pump in engine room may be used also for wrecking and general purposes. There is also one Worthington Admiralty-type donkey pump and a 4-K.W. direct-connected generating set, both located in engine room.

well as other reasons, when the change is made from coal to oil a marked increase of steam capacity is noticed.

This boiler, while it would probably be good for little over 700 I.H.P. with easy firing with coal, as an oil burner will produce steam with ease for 800 to 850 I.H.P.

FUEL-OIL SYSTEM.

The object sought for in installing this fuel-oil plant on the *Sea Rover* was to not only provide a thoroughly reliable and economical system, but, in view of the intermittent duties of a towboat, with its short runs and constant reversals, to make the plant as much as possible entirely automatic.

The two tanks over the shaft alley are used as settling tanks for removal of water, a gage glass and steam siphon being fitted for detecting and removing the water that settles and discharging it overboard. One

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steam pump in the forward fire room draws from all the storage tanks and discharges into these settling tanks. A duplicate set of steam pumps are located in the after fire room, which draw from these settling tanks and feed the burners.

There are fitted, in he oil-suction pipe to these pumps, a duplicate set of strainers for removing dirt or any foreign matter which might cause trouble, and the oil on leaving the pumps passes into a heater where exhaust steam is used to raise its temperature to 160 degrees Fahrenheit. This oil heater is provided with a float mechanism, which controls the speed of the pumps by acting on a throttle valve in the steam pipe.

There is a duplex horizontal air compressor of the Fulton Giant type, with 7 and 12 by 12-inch cylinders, located in the starboard bunker space, and this compressor is controlled by a combined pressure and speed regulator on the machine. The air, compressed to 20 pounds per square inch, passes through the oil heater above the oil bath and on to the burners direct, carrying with it any gases which may form over the oil bath, and thus preventing any dangerous accumulation of gas. An air receiver of about 30 cubic feet capacity is connected on a branch of this air line near the compressor, and serves the purpose of a pulsating chamber as well as an air-storage reservoir.

Precautions against flooding the furnaces, pumps, or hold with oil, in case of accident to the system, are provided for by check and relief valves fitted in proper places in the pipes. The four furnaces are each equipped with two oil burners, and the piping is so arranged that in case of accident to the compressor steam can be used to atomize the oil, instead of air, and the change can be made almost instantly. A small donkey boiler installed in the after fire room, equipped with grates for burning coal, is used to run the compressor and pumps when getting steam on the main boiler.

The system has proved very satisfactory in all respects, and thoroughly reliable and automatic in its action, the fireman regulating his fires simply with the lever on the burners, the supply of oil and air remaining uniform under all conditions, and no trouble has been experienced in producing steam to meet any demand or variation, and with absolute smokelessness.

NAME—Sea Rover. **NATIONALITY**—American. **TYPE**—Tugboat.
LAUNCHED—1902. **BUILDERS**—Fulton Engineering and Shipbuilding Works. **OWNER**—Ship Owners' and Merchants' Tug Boat Company.

Length over all	128 ft.
" between perps	120 "
Beam, molded	24 ft. 4½ ins.
Depth at side	15 ft.
Displacement at 11 ft. mean draft	410 tons
Block coef	.484
Area, midship section	191 sq. ft.
Midship section coef	.755
Bunker capacity	53,400 gals.
Engines, type	compound
Cylinder, diameter	17 and 21 ins.
Stroke	28 "
Valves, piston on H.P., double-ported slide L.P.	
Revolutions, per minute	110
I. H. P	750
Speed	12 knots
Condensing surf	13,20 sq. ft.
Diameter piston rod	4½ ins.
" crank pins	9 "
Length " "	12 "
" connecting rod	70 "
Shafting, crank, thrust, propeller	9 "
Propeller, number of blades	4
Diameter	6 ft. 6 ins.
Pitch	15 " 6 "
Pitch ratio	2.04
Developed area	40 sq. ft.
Auxiliaries, centrifugal pump	8 ins.
Centrifugal pump engine	6 x 6 ins.
Windlass	6 x 8 "
Capstan, steam	5 x 7 "
Steam gear, double engine	4 x 5 "
Two feed pumps worked from crosshead.	
Air pump worked from crosshead.	
Fire pump, duplex	10 x 6 x 10 ins.
Donkey pump	Admiralty, 7½ x 5 x 6 "
Generating set	4 K. W.
Boilers	one double-end Scotch
Pressure	175 lbs.
Diameter	10 ft. 6 ins.
Length	16 " 6 "
Tubes, 384	3-inch
Furnaces, number of	4
Diameter, inside	36 ins.
H. S. for oil burning	2 213 sq. ft.
Compressed-air system	oil fuel

A Bad Collision.

During a very heavy fog in Boston Bay some time ago the steamship *Admiral Farragut*, of the Boston and Philadelphia Steamship Company, collided with the steamboat *Cumberland*, belonging to the Eastern Steamship Company. The resulting damage to the latter vessel is clearly shown in the accompanying engraving. The *Admiral* struck the *Cumberland* head on, forward of the paddle wheel, cutting through the guard and upper works, and crushing the side planking to the water line. Fortunately, however, the break did not extend very far below the water line, and the pumps were able to handle the water and keep the hold clear.

The *Farragut* suffered very little damage, the forward plates and stem being bent, but not pierced.

The *Cumberland* had undergone extensive overhauling last season, and, rather than place her again in dry-dock for the necessary repairs, the owners sold her.

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THE DESIGN OF MOTOR LAUNCHES.

BY W. F. DURAND.

The problem of the design of a motor launch or other small boat naturally divides itself into two parts: the design of the form and the design of the structure. The form of the boat is chiefly responsible for the resistance to driving and hence for the speed with a given power, for the stability, the roominess or carrying capacity, and the safety in general, except as the latter may be dependent on strength. The construction of the boat relates simply to the realization in suitable building materials of the geometrical form decided on, so that the entire structure shall be strong, stiff and stanch, and adapted to the general purposes in view.

We shall in the present article consider briefly the question of the design of form and of the relation of form to the various items noted above. To this end we must first consider the various characteristics of form and their relation to the resultant form as a whole.

FORM.

Form presents itself under two aspects: the form of the under-water body of the boat, and the form of the boat as a whole. The form of the boat above water is, however, largely dependent on the form below the water line, so that the form as a whole is in large measure determined by the form of the under-water body. The qualities of the boat which are dependent on form are furthermore determined chiefly by the under-water body, so that for these reasons it will be sufficient for our present purpose to give our chief attention to the under-water form.

Form presents itself also under two other aspects, represented by *proportions* and by *fineness*.

PROPORTIONS.

By the proportions of the under-water body we refer to the general relation between the three chief dimensions, length or L, beam at water line or B, and draft which we may denote by H. These relations are usually represented by the ratios $L \div B$ and $B \div H$. The range in values of $L \div B$ is from 4.5 or 5 to about 10. Values near the lower limit are met with in wide and beamy boats intended for low or moderate speed, safety, and for ordinary knockabout purposes. Values near the upper limit are met with in long fine boats intended for speed and where considerations of roominess, stability, and weatherliness are not given so great weight. In general, with a given length, the greater the beam the greater the roominess, stiffness, stability, and general adaptation to knockabout uses, while the greater also the resistance and the slower the speed with a given power. On the other hand, the less the beam the less the resistance to propulsion and the higher the speed with given power, advantages gained, however, at the expense of accommodation space, stiffness, stability, and general safety. The relation between beam and draft, or $B \div H$, is naturally dependent on that of $L \div B$. A broad, beamy boat will, as a rule, be also relatively shallow draft, and, *vice versa*, a long, narrow boat will have a relatively smaller value of $B \div H$. The question of proportions is often determined by considerations relating to the service for which the boat is intended. Thus if specially shallow draft is required, the boat must of necessity be relatively broad in order to give the displacement needed to carry the weight of hull and machinery. On the other hand, if there are no limitations on draft the proportions may be made such as to accord with the general character of the design proposed. It must, however, be borne in mind that flat-bottomed, beamy, shallow draft boats and high speed are not consistent features and the latter must not be expected in a boat of this type.

At this point some reference may be made to the dimensions of the upper body as influencing the characteristics of the boat. In general and within suitable limits the higher the freeboard the better the seaworthiness of the boat and the wider the range of stability, while at the same time the greater the air resistance, especially in a head-wind. Thus, if speed is a primary consideration the boat should be low-lying and with the least surface to present to the wind. If, however, comfort, dryness, and general safety are of especial importance, then good freeboard should be provided, especially forward. It thus appears that so far as proportions go the typical knockabout safe "family carriage" boat will be of moderate draft, wide, and beamy, with good freeboard, especially about the bows.

In actual construction all types and proportions of boat are met with to suit varying ideas of designers or to meet varying combinations of requirements on the part of the owner. One thing, however, must be always remembered, and that is that the various good qualities, speed, roominess, stiffness, stability, general comfort, etc., cannot all be combined in maximum degree in any one design. Such considerations always demand a compromise, and it is simply a question of selecting such proportions of under-water body and of form as a whole as shall the best fulfill the requirements of the case in hand. The ordinary motor-boat from 18 to 25 feet long is usually given a ratio $L \div B$ of 5 to 6, higher ratios being met with in larger boats, until in case the length goes to 40 or 50 feet the ratio may rise to 8, or even 10 in extreme cases and where speed is the consideration of first importance.

FINENESS.

Turning now to the other aspect of form, that designated by the term *fineness*, we note that the term relates simply to the extent to which the block form, determined by the principal dimensions L, B, and H, is cut or fined away in various directions in order to give the actual boat form.

WATER LINES.

It will, however, be convenient first to explain the various plans and lines by means of which the form of a boat is represented on the drawing board. If we suppose the form cut by a series of planes horizontal or parallel to the water surface, they will cut from the surface of the boat a series of lines known as *water lines* and having the general form as shown in Fig. 1, *A*. Very commonly only the water lines on one side are shown, since the two sides are the same, and the plan showing such lines is, therefore, known as the *half-breadth plan*. If, again, we suppose the form cut by a series of planes vertical and transverse or perpendicular to the base line, they will cut from the surface

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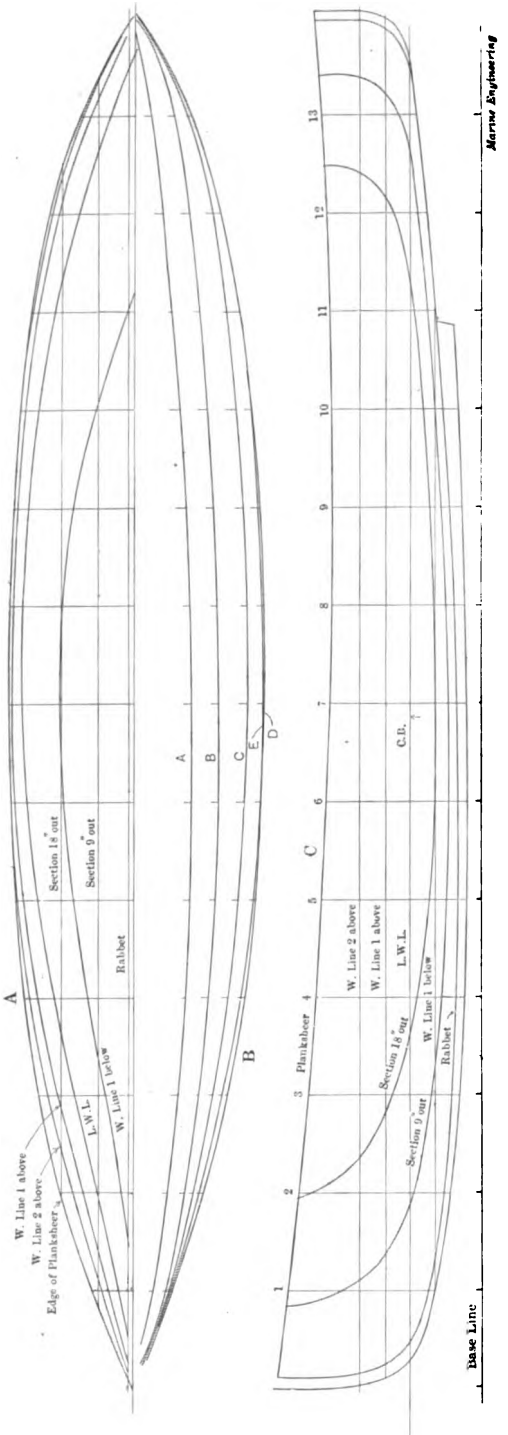

FIG. 1.

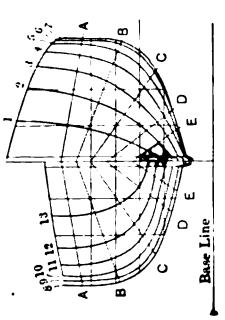

FIG. 2.

of the boat a series of lines known as *sections* and having the general form as shown in Fig. 2. Here again, since it is unnecessary to show the form on both sides of the boat, it is quite customary to show the sections for the after body on one side of the plan and for the fore body on the other, as in the figure. Such a drawing is known as the *body plan*. The plan shown in Fig. 1, *C*, and which gives the side elevation of the form, is known as the *sheer plan*. If the form of the boat were cut by a series of fore-and-aft vertical planes, the lines cut out of the surface would show in such a plan and are called *bow and buttock lines*. Two such lines are shown in the figure. Referring again to Fig. 2, if the form of the boat is cut by a series of oblique planes running fore and aft and lying, as nearly as may be, perpendicular to the surface at various depths, they will cut from the surface a series of lines which may be shown each in its own plane. Such lines, indicated by *A, B, C, D, E*, Fig. 2, are known as *diagonals* and are shown in true form in Fig. 1, *B*. Their chief use is in fairing up the other plans so as to insure a smooth and fair form, especially about the bow and stern. The number and location of such diagonal planes are left to the designer, having in view the characteristics of the case in hand.

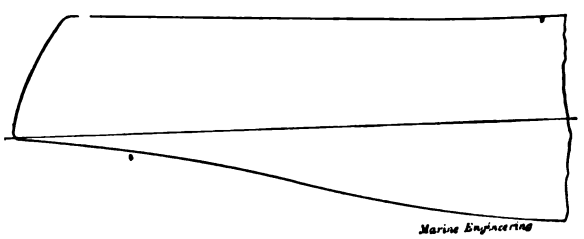

FIG. 4.

Referring now to Fig. 1, *A*, the water lines may be either fined away quickly fore and aft, beginning from the midship section, or they may carry nearly the full width for some little way amidships and then fall off sharply at the bow and stern, with, of course, all intermediate grades of fullness or fineness of water-line form. A water line may thus be said to be full or fine as the water-plane area is a larger or smaller fraction of the rectangle measured by the product of its length and breadth.

The form of water line for small launches will depend much on the character and service of boat desired. For comfortable, roomy boats with moderate speed the water lines will be full, showing a rather bluff bow and preferably a somewhat finer stern. As speed is more and more important, however, the water lines will be fined away, showing a long narrow entrance and fine after body or run. Regarding the after body, these remarks apply more especially to the ordinary or older type of stern, with stern post the full draft of the boat, and deadwood as indicated in Fig. 12. Within the past few years the so-called torpedo-boat or flat stern has, however, become a great favorite with many builders of launches and such craft, and its chief features may be here noted. In such form as shown in Figs. 1, 4, 5, 6 the after body is cut up, so that it comes to the surface at the stern, and the draft is nothing, or practically nothing, at this point. This fining

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in a vertical direction allows, however, the water lines at the stern to be kept full and bluff or rounded, as shown in Figs. 1 and 7, thus presenting in this view, especially in Fig. 7, an entirely different appearance from that of the older form in Fig. 12. In comparing two such forms at the stern it must be remembered that the actual sectional area at any point is in each case about the same, and that in consequence the actual fullness or fineness may be substantially the same. In one case the depth of section is kept nearly constant and they are reduced or fined up horizontally, while in the other the breadth of section is kept greater with a correspondingly full water line, while the depth is de-

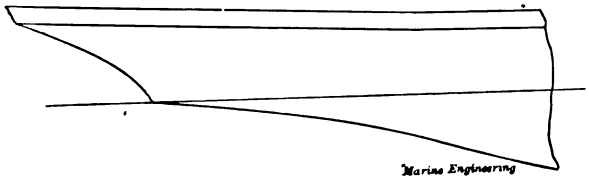

FIG. 5.

creased as the stern is approached, thus fining in a vertical direction instead of a horizontal.

BODY PLAN.

Referring again to the body plan, the sections may at one extreme be nearly rectangular, that is, with nearly flat bottom and straight vertical sides with a slightly rounded corner at the bilge, as in Fig. 8, *a*, or, at the other extreme, more nearly triangular with a sharp rise of floor or even hollowed in at the stern, as in Fig. 8, *b*, with, of course, all intermediate grades of sec-

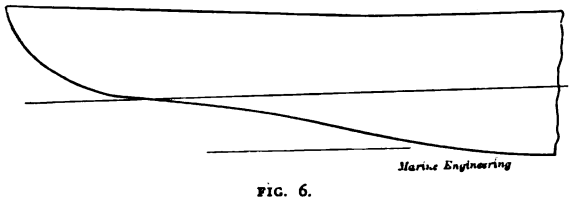

FIG. 6.

tional form, as in Fig. 1, *A*. The general character of the transverse sections is to a considerable extent dependent on that of the midship section, which thus serves as a general index to the form as determined by them. The usual form of midship section for motor boats shows a fair rise of floor on the bottom, with a well-rounded bilge and side somewhat sloping at the water line, rising to the vertical at the rail, as shown in Figs. 2 and 11. The form of section to be adopted in any given case is, however, largely determined by the special conditions of the case. Thus, if the boat is to be of the smallest possible draft, the midship section will necessarily have a rather flat floor and cannot be too much rounded off at the bilge; while, on the other hand, if the boat is high-powered, with propeller of relatively large diameter, and it is desired to have sufficient draft so that the keel will shield the propeller, a form must be selected which will tend toward the deeper drafts, and this will approach the so-called "peg top" section; that is, with a sharp rise of floor and rounded bilge. Again, it must be remembered that a flat, shallow section in a small boat is not the most favorable to seaworthiness, and that for general considerations of safety in a seaway the form of midship section should not too closely approach a shallow rectangle. Also for a given displacement the resistance is greater with a flat, shallow section with sharp bilges than with one relatively deeper and well-rounded on the bilge. For good speed, seaworthiness, and the best average combination of desirable qualities, therefore, the prevailing form of midship section in such boats is somewhat as indicated in Figs. 2 and 11, and for reasons as explained above.

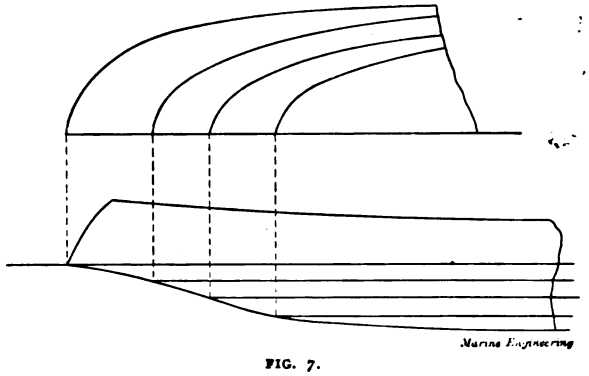

FIG. 7.

With the torpedo-boat stern the after sections become naturally shallow and relatively full. This, however, does not necessarily indicate fullness of form, as explained above. Regarding these two types of form at the stern, the chief advantages and disadvantages may be here noted.

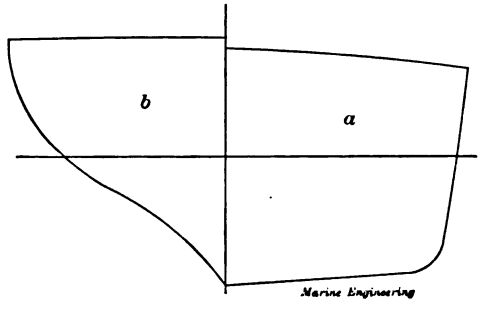

FIG. 8.

The torpedo-boat stern holds a full water line aft and thus tends toward greater roominess and comfort. The greater water-plane area is also favorable to stiffness and stability. Such form, especially with relatively large beam, is also more favorable to speed than the older form of stern. The water has a somewhat freer run to the propeller, the tendency of the boat to "squat" is less pronounced, and it is generally considered that, with a given power, better speed may be thus realized than with the older form of stern. On the other hand, such form of construction does not furnish protection to the propeller as with the older form, and it is also somewhat more difficult to give to the upper body at the stern such forms as we have been accustomed to consider graceful and pleasing. The structural features of such a form of stern may also present somewhat greater difficulties than the

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older type. These various considerations must, therefore, be taken into account in selecting the form of stern, but, as indicated by recent practice, this form should be adopted whenever speed is an important consideration, and, perhaps, in the usual case unless protection to the propeller is a matter of unusual importance. In such case a thin skeg or even separate bar of steel is sometimes fitted to such a form of stern simply to furnish protection to the propeller.

COEFFICIENTS.

The general question of fineness is usually referred to a series of so-called fineness coefficients, of which the more important for our present purposes are three, as follows:

The *midship section coefficient* is the ratio of the area of midship section to that of the surrounding rectangle, or $B \times H$. Its indications show the extent to which the rectangle BH is pared or fined down in order to give the actual midship section.

The *block coefficient* is the ratio of the actual volume of under-water body to the surrounding block, $L \times B \times H$. Its indications show the extent to which the block LBH is cut away in order to give the actual form of the boat.

The *prismatic coefficient* is the ratio of the actual volume of under-water body to that of a solid the length of the ship, and with a constant section that of the midship section. The indications of this coefficient relate to the extent to which the sectional areas fore and aft are reduced in comparison with the midship section, or, in other words, it shows in a general way the distribution of volume fore and aft the length of the boat; or, still otherwise, it shows the relation between the average area of section and the area of midship section. Thus a prismatic coefficient of .65 would denote that the average area of section was .65 of the midship section, showing considerable fining down in one way or another, while a value .78 would show similarly a much smaller reduction of sectional area fore and aft, and a much fuller form as regards distribution of volume fore and aft.

DESIGNING FROM OLD LINES.

Having thus discussed in a general way the various features of form and their influence on the characteristics of the boat, we may approach the main question of the determination or design of a form in any given case. It should first be noted that but rarely is such a form designed absolutely new and without reference to previous forms. In any office where such work has been done in the past there may usually be found some form whose characteristics closely approach those of the form under consideration, and from such a form as a start the desired form may often be developed by relatively simple modifications. These modifications may be of two kinds: those involving a change in the proportions of length, beam, and draft, and those involving a change in the fineness coefficients, as discussed above.

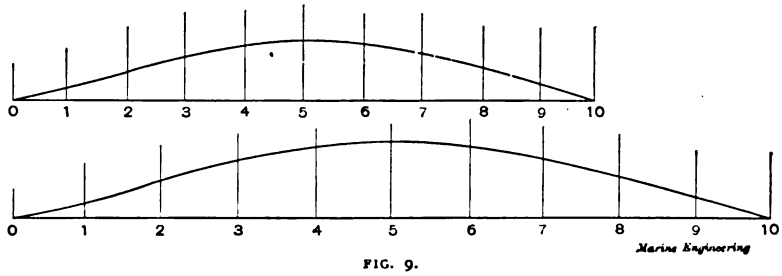

FIG. 9.

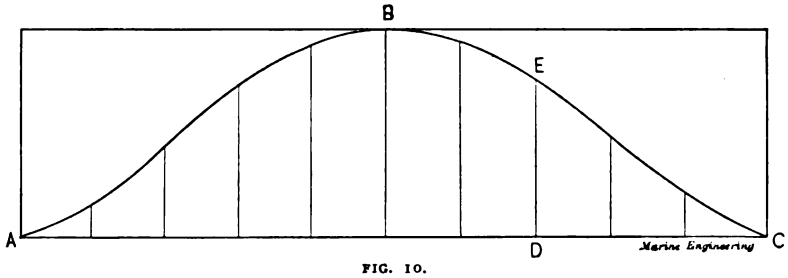

FIG. 10.

In the simplest possible case, if the proportions are suitable and the form characteristics satisfactory, it may be considered that no change in the lines is necessary, and that only changes in the actual dimensions will be required. In such case no new design is needed. All dimensions are increased or decreased in the same constant ratio and the determination is complete. In such case it is not, as a rule, necessary to make any change on the drawing board or to redraw the lines to a different scale. All such changes may be made in the general manner suggested below when the boat is actually laid down full size in the boat shed.

In the more common case the fineness coefficients and the form so far as determined by them may be acceptable, but it may be desired to change the various proportions of L, B, and H. Thus, suppose the original lines to relate to a boat 28 feet long, 5 feet beam, and 2 feet draft. It is desired to use the same general characteristics of form for a boat 33 feet long, 5 feet 6 inches beam, and 2 feet 6 inches draft. The various

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proportions between the new and old would, therefore, be as follows:

Length ratio=33÷28=1.18. Beam ratio=66÷60=1.10. Draft ratio=30÷24=1.25. That is, the new boat will be 18 per cent. longer than the old, 10 per cent. wider, and with 25 per cent. deeper draft. Here again no work whatever need be done on the drawing board, as the changes required may all be made when laying the form down full size. A few hints regarding this operation may, however, be given. In order to obtain the form of section at each frame, spaced as may be desired, the water lines or half-breadth plan will be needed. To lay this down we note that the intervals between sections must be increased in the same ratio as the length. Thus, suppose in the original drawing that 10 intervals were used, giving a spacing of 2.8 feet fore and aft. The new spacing will be similarly 3.3 feet. The ordinates on each of these stations must then be scaled from the original drawings or taken from a table of offsets, and multiplied by the breadth ratio 1.1. This will give the lengths of ordinates to be

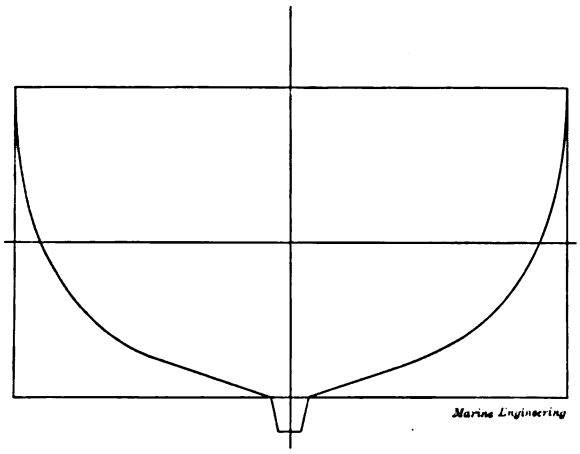

FIG. 11.

set off at the new stations, and the result will be the new water lines. This operation for a single water line is indicated in Fig. 9. In a similar manner the other water lines are run in, thus giving the half-breadth plan as desired. The new length of 33 feet may then be divided into any frame spacing as desired, and the locations of the frames drawn in. To lay down the body plan for these frames we then note that the vertical spacing of the ordinates must be increased in the ratio of the drafts, or 1.25. If, therefore, the old spacing was 3 inches the new must be 3×1.25=3.75 inches. Lines laid down to this spacing may then be laid off and the ordinates taken from the new half-breadth plan will give correctly the forms of the sections or frames.

In carrying out such operations, and after the lines themselves have been determined, it may be desired, as a matter of record, to lay down a new set of water lines in the body plan, spaced at some even interval, as 3 inches, in order to make the ordinates of the present form a matter of record in a table of offsets. In such case the additional lines may be preferably run in with a different color in order to avoid confusion between the two sets of lines.

There are, of course, many practical details of the operation which we cannot refer to in the present brief account, but in the general manner indicated it will be possible to lay down a new set of lines from an old, and having the same coefficients of form, but with proportions of *L*, *B*, and *H* changed as may be desired. It may often happen that two or even all three of the ratios above referred to are the same, as, for instance, in a case where we wish to retain in the new boat the same ratio of beam to draft as in the old, or, as may happen, where the proportions throughout are the same, the size alone being changed, as in the case first mentioned above. In case the new dimensions are smaller than the old or some of them smaller and some of them larger, the same general method will apply; and in all such cases where the form coefficients are to be left unchanged and the proportions alone modified, this general procedure will serve to determine all features of the new form as may be desired.

In many cases, however, it will be desired to modify the form coefficients as well; that is, to change the character of the midship section, to fill in here or fine away there, and so in various ways to modify the characteristics of the original form. In such case the problem should be taken up on the drawing board and the new form determined to a first fairing before proceeding to lay it down full size on the floor. The extent of such modification may be determined by three considerations: the satisfaction of the eye as a judge of form or proportion; the satisfaction of the judgment regarding suitable or desired values of the form coefficients; or the provision of some needed dimension or space for reasons of structure or arrangement.

If the extent of such changes is not great the original lines, especially the body plan, may be taken as a foundation, and the changes lightly sketched in freehand, firing or filling in and changing until from one consideration or another the desired form is approximately determined. If these changes have been carried out on the body plan the result on the fairness of form must next be determined by reference to water lines, bow and buttock lines, or diagonals. It will thus be found that, in order to run in smooth lines on the second plan, slight changes must be made in the sections of the body plan, still retaining, of course, their own fairness and smoothness of form. In this way it will be necessary to make slight changes back and forth between the two sets of plans, say the body plan and water lines, until finally both are as nearly fair as may be determined on the reduced scale used on the drawing board. As a final test a few diagonals or bow and buttock lines may then be taken, and, if fair, the entire form may be considered ready for transfer to the floor. In making any such series of changes it must, of course, be remembered that changing any one section, for instance, will necessitate a change in all the water lines in the neighborhood, and hence, in order to retain the latter fair, a change in all the sections for some little way fore and aft. This operation of changing back and forth between two or more sets of lines, or fairing, as it is termed, involves many minor points of detail which cannot be here considered, but which will appear in the actual case, and regarding which experience is the best teacher. The final

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purpose is, of course, the determination of a smooth and fair form with the general proportions and characteristics considered desirable in the case in hand, and if a form nearly fulfilling the desired conditions can be found as a start, the method above outlined will serve to develop the desired changes.

CURVE OF SECTIONS.

The characteristics of the under-water body are often judged in large measure by the so-called curve of sections or curve of sectional areas. This is a curve as illustrated in Fig. 10 and laid off on the length of the boat, and such that any ordinate, as *DE*, represents the area of section up to the load line at that point in the length. It may be shown that this curve with boats having the older form of stern represents in its general form, as regards fullness, the average water line, and also that its own fullness coefficient, or area divided by length times greatest height, is exactly equal to the prismatic coefficient as defined above. This curve shows in fact just how the volume of the under-water body is distributed fore and aft, and is of great importance from the standpoint of resistance and propulsion. To lay down such a curve in any case, having given the body plan, it is simply necessary to

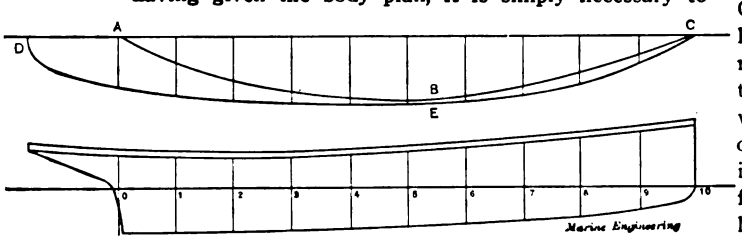

FIG. 12.

find the area of each section by itself and then to plot them to any convenient scale in the manner shown in the figure. To find the areas a planimeter is most convenient, though of course they may be found numerically by the use of Simpson's or other similar rules for the areas of irregular figures. In the case just referred to, of changing by fining or filling in, either in fore body or after body or both, the smoothness with which such change in the distribution of volume is effected may be judged by the curve of sections, and, as a rule, it may be recommended to compare the old and the new curves as a further test of the features of the new form.

LAYING DOWN A NEW DESIGN.

We have thus far considered the design of form, starting with an existing form as a basis, and requiring only relatively slight modifications to fulfill the conditions of the case in hand. In the more general case, when no such form is available, the entire design must be new from the start and the chief steps in such an operation may now engage our attention. It is clear that such a form cannot be developed without something to start with. It cannot be evolved out of the air, so to speak, and one must have certain conditions or characteristics from which to begin the solution of the problem. These fundamental data must be either furnished us by the conditions of the problem or must be assumed to an extent sufficient to make the solution practicable. The features to be thus chosen or assumed will vary somewhat with the taste or choice of the designer. Here as elsewhere there is no one way along which we must travel. Many routes lead to the same goal, and it becomes a matter to some extent of individual choice. For most cases the following may be suggested as a safe and satisfactory routine.

The length, beam, depth, and draft are supposed to be given. The next step may be to lay out the form of midship section, or if the given beam is that at the water line the beam and draft give the rectangle surrounding the immersed part of the section. In either case the form of the entire section must be sketched in, having in view the general influence of this feature on the design as a whole, as previously discussed, and selecting such a form as may seem best adapted to the purposes in view. This step is indicated by Fig. 11.

Having selected the form of midship section, the next step may be to run in a sheer line and keel as in Fig. 12, thus fixing the general contour of the boat as seen in side elevation. At this stage the form of stern must be selected, whether torpedo-boat or with deadwood, and the keel line then adjusted accordingly. One of the great difficulties with the torpedo-boat stern has been the adjustment of the upper body in such manner as to suit our ideas of comeliness. The full typical form is shown in Fig. 4, and, while often met with in pleasure boats, does not always meet the views of the purchaser. Other forms of treatment are shown in Figs. 1, 5, 6, with varying degrees of roundness or fullness for the horizontal sections above the water line. The next step may be to run in a load-water line, *A, B, C*, Fig. 12; a rail line, *D, E, C*; and a curve of sectional areas, *A, B, C*, Fig. 10. These three lines cannot be selected independently, but must be determined with reference to each other. If the form has the older stern, as in Fig. 12, the curve of sections, as we have seen, represents nearly a mean or average water line, so that in relative fineness the curve of sections will be fined away the most, the load-water line next, while the rail line will be much fuller, according to the room required and the desired form for the upper body of the boat. The load-water line and rail line must agree at the midship section with the form decided upon for this section, as in Fig. 11; but aside from these two points and the ends, the lines are undetermined and must be taken according to the best judgment available. It is probable that the three lines thus selected will not satisfactorily agree; that the curve of sections will prove to be too full or too fine for the load-water line or that the latter is not of form suitable for the curve of sections as taken. All this, however, can only be ascertained by the further development of the form. To this end we may take any section, as No. 7, and note its area as measured from the curve of sectional areas. Divide half this area by the product of the half breadth of the section, as shown by the water line at No. 7, multiplied by the depth as taken from the sheer plan. This will give the fineness coefficient for this section. It will show to what extent the rectangle *A, B, C, D*, Fig. 13, must be cut away to give the half section *A, E, C, B* with area as required. A little experience will enable one to

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make a close estimate of the shape, knowing the coefficient to be realized. Thus, if the area of No. 7 is to be 70 per cent. of the area of the rectangle, it shows that *A, E, C, B* must be 70 per cent., or a little less than three-quarters, of *A, B, C, D,* and a little experience will make it possible to sketch in a section nearly fulfilling these conditions. A few trials checked by a planimeter will serve to quickly bring the area to the value desired within a satisfactory limit of accuracy. In thus sketching in the section reference must be made to the point *F,* determined by the rail line, so that the entire line *A, E, C, F* may be run in smoothly and fair and with the general character of section desired. In the same manner the other sections may be run in, care being taken to give to each the general characteristics of that next to it, so that the transition in form from the midship section may be gradual and smooth. For this reason it will be well to start from the midship section and work each way, running in No. 6, for instance, quite similar in form to No. 5, the midship sec-

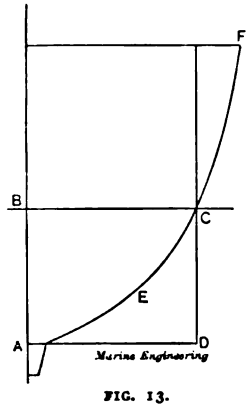

FIG. 13.

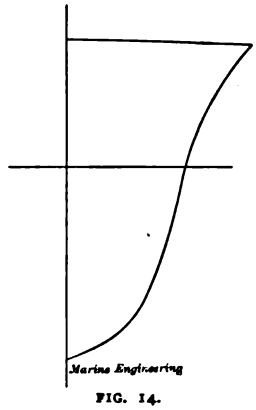

FIG. 14.

tion, and only reducing it as may be required to suit the decreased width at water line and decreased area as shown by the curve of sections. Next No. 7 is determined, with only a moderate departure in general form from No. 6, but with probably a growing departure from No. 5, and so on to the bow. In the same general manner the after body is determined, both under water and above. In case at any section the various lines assumed do not agree in such way as to make the form practicable, the fact will be shown by an excessively large or small section coefficient at this point. Thus it would be quite possible to assume a curve of sections and a load-water plane so related as to require a given section to be almost or quite rectangular at one extreme, or triangular, or even finer, at the other. In such a case the form of these curves must be so modified as to give sections throughout having the general character of form desired. In some cases it is desired to keep the rail line forward especially full for roominess. This may be done by introducing a reverse curve in the sections above the load-water line, as shown in Fig. 14. In this way, without increase of under-water body and with relatively fine under-water lines, the upper body may be made full and roomy.

When the sections have thus been sketched in the result will be a series of lines fulfilling closely the conditions assumed as regards distribution of area fore and aft, load-water line and rail line. It is practically sure, however, that a boat built to such lines would not show a fair continuous surface, but would develop humps and hollows, flat spots and irregularities, surprising to one not accustomed to such matters. If, therefore, in a general way the conditions specified are fulfilled, the next step must be to insure the fairness and continuity of the form. Space forbids any detailed description of the operations involved in thus fairing the first crude results. In general the first step will be to run in a further series of water lines, preferably, perhaps, one at mid-draft next. The probabilities are that this will be found unfair and will show needed modifications in the sections. The same general operations are carried out here as referred to at an earlier point in connection with fairing up after slightly changing a given form. The mid-draft water line will show needed changes in the sections, and these will require further changes in the water lines, and so it is often necessary to work back and forth, gradually approaching a condition where both sets of lines shall be fair. In the same way other water lines may be run in and faired one-half way as nearly as may be between the rail line and load draft, and then others, until the two series of lines are as nearly fair as may be readily effected with the reduced scale used on the drawing board. In fairing the lower part of the under-water body, and especially about the bow and stern, much help may be derived from bow and buttock lines or from diagonals, as previously discussed. One advantage of diagonals is that they often lie approximately in the line of the strakes of planking and hence show just how such strakes will be bent and furnish a test of fairness in this direction. Often the bow and buttock or diagonal lines will serve to show small residual irregularities of form or undesirable features, such as relatively flat or concave spots, which might have been overlooked if tested only by sections and water lines.

One thing must be clearly understood, and that is that there is no royal road to the fairing up of a ship's form when developed in this way. It requires care and patience and often a long series of transfers and changes back and forth before all sets of lines are fair and "sweet" and the conditions imposed are all fulfilled.

The method of developing a design outlined above is adapted especially to cases in which the qualities to be obtained may be satisfactorily expressed in terms of the form coefficients and the general characteristics of a curve of sections. In cases where the judgment is uncertain on some of these points, or where the designer may prefer to determine the form more directly, the same ultimate end may be reached by selecting first a midship section, as before, and then with the pencil sketching in lightly the various half sections of the fore body on one side and of the after body on the other. Aid may be obtained by looking at a body plan with features somewhat similar to those desired, and distributing the sections in a generally similar manner. By carefully noting the relation of one section to the next and working from the midship section each way, a form may be developed which will not be very far from fair, and which will possess the general features desired, so

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far as such may be determined by reference to the sections. The fairness and continuity, both of surface and volume, must then be determined by running in from the sections thus laid down a set of water lines or diagonals and a curve of sectional areas. These will, doubtless, reveal irregularities in the surface form and in the distribution of volume. With such indications in hand, the sections may then be modified and faired up with the water lines or diagonals, and the resulting form coefficients and curve of sections noted, until, in this way, the various plans shall be made fair and the general features shall be considered satisfactory for the case in hand.

The first method, in substance, involves the fixing of certain conditions or features, as expressed by the form coefficients and curve of sections which the form is to fulfill, and then determining a form which shall fulfill these conditions as nearly as may be finally decided desirable. The second method, in substance, involves the determination of a form direct without other guide than the eye, and then the testing of this form by reference to the form coefficients and curve of sections, until again the result shall be considered satisfactory for the case in hand.

Still otherwise, especially in earlier years, the forms of boats were commonly determined by direct reference to a model formed in wood and to such reduced scale as convenient. This method has the advantage that it allows of eye judgment of the solid form, and this is more satisfactory than by judgment "in the flat," as on a drawing board. It has the disadvantage that the form must be developed wholly by eye judgment, and that in case, in the modifications here and there, it should be made too fine, the correction is not easy. It is often desired to note the result, for example, of fining here and there. This may be readily done on paper, lines may be run in and rubbed out, and the form may be modified as often and as much as may be desired, without prejudice to the final completion of the problem, with the same general layout as at the start. With a wood model, however, it is, of course, impossible to take off and then put on, and great care must be exercised when approaching the final condition, lest too much be removed and a spot undesirably lean be produced.

After the wood model has been brought to what seems to be a satisfactory form, the various sections and water lines should then be located and the ordinates determined by calipering, or by such other method of measuring as may be convenient. From these measurements the form coefficients should be determined and the curve of sections laid down, so that the result may be judged in the light of these items. The result may indicate a satisfactory combination, or it may show that further change is needed, especially as regards the relation between draft, displacement, and carrying capacity.

On the other hand, when the form is determined on the drawing board, especially if it contains features of novelty, it may be recommended to make a model representing such form before laying it down full size and proceeding with the construction. This is the inverse of determining the lines from the model. The operation of cutting a model to represent a set of lines involves many details, and we can only note briefly that it may be done in two general ways. (1) A solid block may be glued up and then pared down, as tested by molds cut out to fit around the form of the sections, until, at a series of stations, the block is reduced to the desired form. The intermediate parts are then brought down and the whole faired up. (2) A series of "lifts," or boards of thickness to represent the space between the water lines, is prepared and the water lines laid out one on each. The lifts are then cut out, each to its own water-line form, and these are then pegged together or glued up, as may be desired. The corners are then brought down so that the form is smooth and continuous and with water lines as laid out. Very often, from the indications of such a model carefully made, it will be found desirable to slightly change the form one way or another, and this may be done on the drawing board and followed up on the model, until, between the two, the result fulfills the judgment taken from all possible points of view.

At this point it may be asked, What assurance have we that when built the boat will come to the draft designed? In reply we can only say that in the absence of actual information as to the weight of the boat and machinery, or elaborate calculations relating to the same, we may depend upon it that if of ordinary proportions and construction, and if powered within reason, there will be left over a certain margin before bringing the boat down to her designed draft. This margin may be utilized for passengers, etc., and if the boat is of any but the smallest size there will be sufficient range to provide for all ordinary requirements with a boat of this character. There is no requirement, of course, that the boat should always or necessarily run at just the designed draft. In small boats there is often much variation according to the load carried, and so long as the freeboard remains sufficient for safety the fundamental purpose of the boat may be satisfactorily fulfilled. With accurate knowledge of the weights of boat and machinery or with a sufficiently careful and extended computation, the amount of carrying capacity at any water line may, of course, be accurately found by subtracting the total weight of boat, machinery, and equipment from the total displacement as given by the immersed volume up to the water line in question. In the usual case, however, there will be some uncertainty regarding the schedule of weight, and the best estimate must, therefore, be made which the data available will permit.

In this brief discussion of some of the points which will enter into the considerations of the design of the form of a small launch or motor boat, many details have been omitted, or only briefly referred to. The purpose has been to aid those who already have some acquaintance with such matters to use their judgment and experience to the best advantage, and to give such hints as may enable those quite unfamiliar with the matter to undertake the study of the problem of design in the way likely to be most instructive to them, and in which they will be the best able to learn for themselves, and thus to develop such skill as they may have for this class of creative work.

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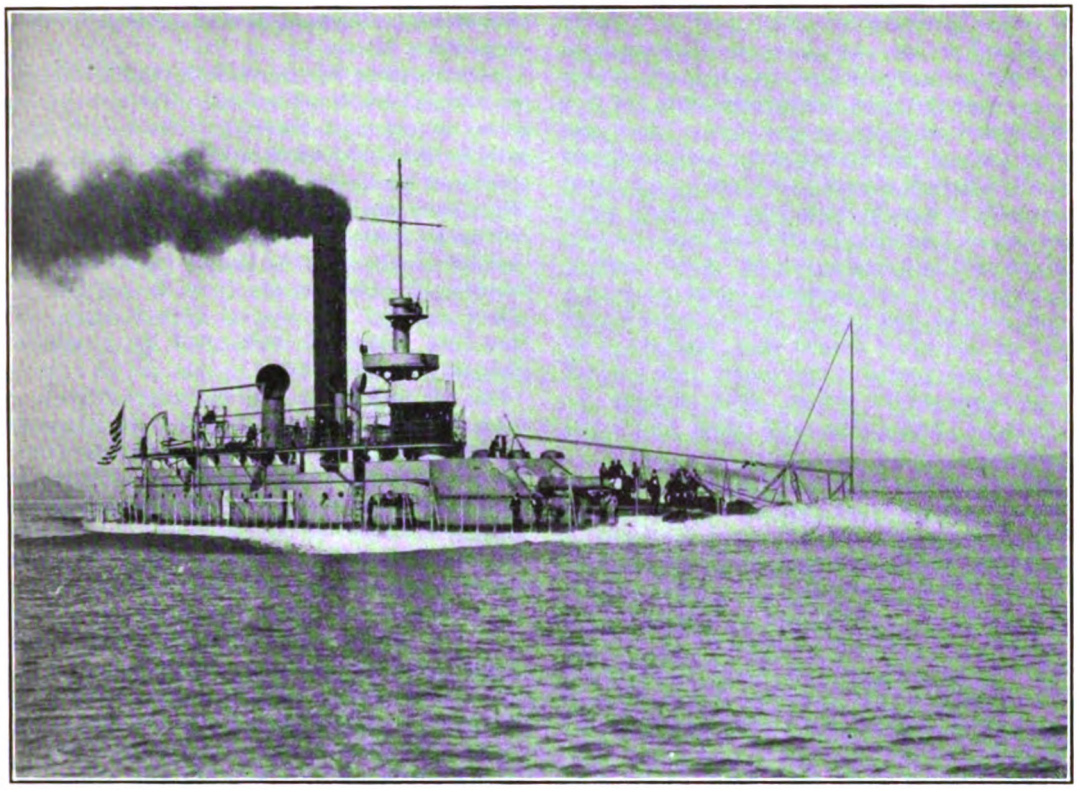

UNITED STATES MONITOR WYOMING ON TRIAL IN SAN FRANCISCO BAY.

Monitor Wyoming.

The latest addition to the heavy ships of our navy on the Pacific coast took place with the acceptance of the monitor *Wyoming*, built by the Union Iron Works, of San Francisco, Cal. The keel was laid on April 11, 1899, and the vessel launched on September 8, 1900. The *Wyoming* was recently run on several preliminary trial trips in San Francisco bay, upon which the required speed was exceeded. In November the final trial was run at sea outside of Golden Gate, and a speed of 12 knots was maintained.

The *Wyoming* is one of four monitors authorized by act of Congress, May 4, 1898, and is of the following dimensions:

Length on water line.....	252 ft.
Extreme beam	50 "
Depth, molded	14 " 10 1-2 in.
Draft, mean	12 " 6 "
Displacement	3,214 tons.
I.H.P.	2,400

The machinery consists of two sets of vertical triple-expansion engines, 17, 25 1-4, and 40 inches being the cylinder diameters, and the stroke 24 inches, indicating about 2,400 H.P. Four Babcock and Wilcox boilers are installed, having 216 square feet grate surface.

In point of armor, the low freeboard is protected by armor 11 inches thick, tapered to 5 inches at the ends. The forward turret armor is 10 inches thick and protects the main battery, consisting of two 12-inch breech-loading guns. The turret is mounted in a barbette. In the superstructure are mounted four 4-inch R.F.G., three 6-pounders, five 1-pounders, and two Colts.

Oil-Tank Vessels.

BY D. CURRIER.

The carrying of crude petroleum in bulk, and the experiments of adopting oil for fuel in place of coal, will in a great measure change the general construction of ships for the oil trade, both in building and repairs. A number of Lake boats have been brought to our Atlantic coast repair yards, where they are being reconstructed, and several oil companies have given out contracts for the building of oil-carrying barges and steamships.

Of those rebuilding at the repair yards, the style of work and the necessary changes thereby, the following is a brief synopsis.

The decks are generally overhauled, and all butt laps, landings, and riveting are increased to insure oil-tight work. In many places, where the old spacing of rivets is 7 to 8 diameters, the old rivets are left in place and new ones are equally spaced between. In connections where there is now oil-tight work, the rivet spacing runs about 4 diameters, except in the frames and beams, where it is as high as 7 and 8 diameters; but in landings, which are usually double-riveted, and in treble and quadruple butts, the oil-tight spacing of rivets required is 3 to 3 1-4 diameters. In angle iron, where the size of the bar permits, staggered riveting is used.

Looking to its future efficiency, the decks have additional beams of angle steel, 6 by 3 1-2 by 3 1-2 by 1-2 inch, fitted between the present ones and connected to the frames and center-line bulkhead by 18 by 1-2-inch brackets. Half beams, bracketed in a similar manner, are fitted in way of the hatchways.

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These vessels generally have 8 by 3 1-2 by 3 1-2 by 1-2-inch channel frames, and to insure oil-tightness at the decks, and to further stiffen the same, the frames are cut just below the main-deck stringer plate and at a height of 6 inches above the stringer plate. The stringer angle on top and the intercostal bar underneath are removed, and a flanged plate is substituted on top, about 18 inches wide, 5-8 inch thick, and extending about five frame spaces, riveted to the stringer plate and connected to the shell by a double row of 7-8-inch countersunk rivets about 3 1-2 diameters center to center. This flange plate is well calked. Where these frames have been cut above the flanged plate, brackets 24 by 1-2 inch are fitted, riveted to the frames with 7-8-inch rivets, and connected to stringer plate, clearing the flanged plate, by double clips, with about four rivets in each flange.

The ship is divided into eight oil-tight compartments, into which the crude petroleum is pumped in bulk. The divisions are: five transverse bulkheads of 7-16-inch plating, and a continuous center-line bulkhead with the same weight of plating. These bulkheads are stiffened by 6 by 4 by 1-2-inch angle bars, spaced about 24 inches apart. In one case a 6 by 3 1-2 by 3 1-2 by 1-2-inch Z bar was used. All the bounding angles are 5 by 5 1-2-inch angles, with staggered double rivets in each flange and all countersunk. Snap riveting is not generally used.

At certain distances apart, web plates, bounded at each edge, top and bottom, by 3 1-2 by 3 1-2-inch angle bars, are put in for the extra stiffness, both horizontal and transverse. The center-line bulkhead is stiffened in a similar manner.

Because of the old riveting in the vertical keel angle-iron bars connecting tank top to keel, the center-line bulkhead is moved 5 inches off the center line of the ship, and to further promote equal balancing the bulkhead center line in each oil-tight compartment is alternately placed, first on the starboard side, then on the port side, and so on, keeping 5 inches off the center line to avoid the old riveting. Where the old bulkheads are used, they are all stiffened and strengthened by vertical and horizontal stiffeners, and the new 5 by 5-inch bounding angle is substituted for the old and smaller one. All the plating on these bulkheads, both transverse and center line, is laid vertically, the plates averaging about 5 feet in width, in several places 7 feet, and extending from tank top to upper deck.

From main to upper deck expansion trunks are fitted, which utilize the old hatch spaces, extend to about 6 feet above the upper deck, and are about 14 by 36 feet. They are subdivided by the transverse bulkheads and are plated over on top. Hatches are fitted between the expansion-trunk beams, and water- and oil-tight covers are battened down over the hatches.

Just aft of the hatchways forward and on the main deck is the pump room, in which two sets of double-acting pumps, Worthington, Dean, or the like, are placed. From these pumps run the suction and discharge pipes to each oil compartment. These pipes are so arranged that one set of pumps draws from two compartments, the second set from two more, and when necessary both can be brought to bear on one compartment. Forward of the oil compartments is the cargo space.

In meeting the new work with the old, where possible the old work is not touched. The riveting, perhaps, is one of the most important factors, and great care must be taken. All seams are double-riveted, with close spacing of rivets, running about 3 diameters. In some places there are treble-riveted butts, but generally they are double-riveted like the landings. Outside of the complete overhauling and the placing of new work, the positions of compartments on decks are not changed, unless, perhaps, the removal of coal houses and the like. The machinery and boiler space remains unchanged.

The oil is pumped into the compartments until it reaches a level about 2 feet above the upper deck in the expansion trunk.

It will be interesting, certainly, to watch the tests of these vessels as oil carriers and determine whether it is cheaper to renovate the old vessels or build new ones for the oil trade, so rapidly coming into prominence and destined, perhaps, to increase many fold.

Oil Fuel on the Pacific Coast.

The use of oil fuel is the all-absorbing topic along this coast at present. The indications seem to be that before long a coal-burning steamer will be a curiosity.

Prior to January 1, 1902, the only marine oil-burning installations to be found here were on the local ferry-boats, on a few steam coasting schooners, and local harbor craft.

Starting with S.S. *Enterprise,* of the Matson Navigation Company, which went into commission as an oil burner a few months ago, there has been a steady increase in the use of this system for deep-sea steamers. The *Enterprise* plies between San Francisco and the Hawaiian Islands. Her first trip from this port was looked upon as more of an experiment, and many people argued that she would never get back, unless she came under sail. Her success, however, has been well assured in the subsequent trips. A detailed account of this matter was given in MARINE ENGINEERING for September.

Probably the best evidence of the success of this steamer is shown by the fact that the Matson Navigation Company is now fitting up another steamer in the same manner. This company recently purchased the United States Army transport *Rosecrans* and is now having her overhauled at the Union Iron Works for conversion into an oil-carrying, oil-burning vessel. She will have a capacity for 22,000 barrels of oil in bulk and will run to the Hawaiian Islands.

Following the *Enterprise,* the next steamer to leave port with oil fuel was the *Mariposa,* a description of which was given in Admiral Melville's report printed in the December number. This vessel has proved to be the most successful of any of the new installations so far. The owner, the Ocean Steamship Company, has ordered her sister ship, the *Alameda,* to be taken off the line and converted into an oil burner. The American-Hawaiian Company has the two newest and largest steamers burning oil—namely, the *Nevadan* and *Nebraskan.* These ships came round the Horn to engage in the Pacific coast-Hawaiian trade. They burned coal

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on this trip, but immediately on arrival were converted into oil burners, all the necessary apparatus having been brought out from the East. In this system oil is atomized by air at a low pressure—in the neighborhood of eight ounces. On the *Enterprise* steam is used for atomizing, and on the *Mariposa* compressed air at 20 pounds per square inch is used for this purpose. At present the results from only the *Mariposa* are given out.

Much valuable time is saved in supplying a vessel with oil fuel over the time taken to coal a ship. The *Nevadan* gave an object lesson in this respect after her arrival at San Francisco. On her way from New York to this port she burned coal, and at Coronel, South America, she coaled for San Francisco. It took two whole days to fill her bunkers. When she filled up with oil here 4,500 barrels were transferred into the tanks in five hours, and the operation involved no soiling of decks or any hard labor on the part of her crew. Forty-three hours were thus saved in the time of taking oil fuel aboard, as compared with the time consumed in coaling for a voyage of corresponding length. Time is as much of an item to be saved as anything else. Oil can be handled without the employment of manual labor, transferred to the tanks aboard ship, and from them to the furnaces by its own gravity.

The growing use of oil on this coast has caused many steamers formerly engaged as colliers to break into the general carrying trade, and this has worked to the great disadvantage of sailing vessels. Most of these ships now bound here from Australian ports, which would, under former conditions, have been laden with coal, are coming in ballast. Regardless of this fact, additional tonnage is coming to this coast to engage in regular trade between here and the Orient. This seems strange, in view of the number of United States Army transports now laid up at this port and offered for sale. The recent order of the Army Department to send but one ship per month to the Philippines caused the transports to block up here, until no less than eight (a good-sized fleet) were lying idle in San Francisco harbor. Many of these were offered for sale, but could bring no satisfactory figures, and so were retained by the Government.

Annual Report of Rear Admiral Bradford.—Admiral Bradford, Chief of the Bureau of Equipment, in his annual report to the Secretary of the Navy, again protests against the action of the Department in substituting a naval constructor for a line officer in shipbuilding works. In the construction of steamship vessels the work is generally supervised by an experienced master mariner and chief engineer, and the admiral believes it is essential that the equipment of a warship should also be under the supervision of men with an extended working experience. The total amount of coal purchased during the year was 382,040 tons, at an average cost of $5.81 per ton, against $7.01 last year. The amount used for steaming purposes has increased more than five times during the past ten years, but the amount of domestic coal purchased has increased 34 per cent. and the foreign coal bought decreased 16 per cent. The admiral recommends, as in his previous report, the building of two large steam colliers capable of carrying 10,000 tons of coal as cargo and 1,000 tons in bunkers.

ATLANTIC TRANSPORT STEAMERS MISSOURI AND MAINE.

Among the most interesting vessels under construction in America to-day are the *Missouri* and *Maine*, building at the Maryland Steel Company's yard, Sparrow's Point, Md., for the Atlantic Transport Company.

These vessels, although of the same length as the *Manhattan* and *Michigan*, built by Messrs. Harland and Wolff, are quite different in all other respects, the hulls being under the "three-deck rules," and thereby stronger. They have also two feet more beam, more commodious quarters, and more power, together with increased speed. The general dimensions are given in the table at the end.

The hulls are constructed of mild steel throughout, built under Lloyds' rules for the highest class. The classification of the American Bureau has also been obtained. The frames are of channel bars, spaced 30 inches center to center amidships and aft, reduced to 26 inches at forward end. Provision has also been made for the great stresses occasioned in full-modeled steamers when running light, by doubling the frames and by thickening the shell plating and treble riveting the laps of same. There are four steel decks, extending all fore and aft, with channel beams fitted on every frame. The upper deck forward and aft in the crew spaces, and the shelter deck above these spaces, are wood-sheathed.

Eight water-tight bulkheads extend to upper deck. In addition to this, there are three bulkheads extending to middle deck to form coal bunkers, and one to middle deck to form deep tank. The peak bulkheads extend to shelter deck. The bulkheads are stiffened by a method designed by the Maryland Steel Company, securing a maximum amount of strength with a minimum of material. This arrangement also facilitates the loading and discharging of grain, which is generally carried in these compartments.

The water bottom, constructed on the cellular system, extends from the forward collision bulkhead to a partial bulkhead on frame No. 22 aft. There are solid floors fitted on every frame, with three intercostals on each side of center line. These intercostals are carried well forward and aft, stiffening the flat portions where pounding is likely to occur. Aft of the water bottom a water-tight flat on the line of second hold stringer forms the shaft alley recess, being divided at center line by a water-tight bulkhead provided with a door to facilitate repairs. The capacity of water bottom is 1,524 tons. In addition to this there are 189 tons of ballast in the peak tanks, and 2,005 tons in the deep tanks forward and aft.

The lower part of the stem, the stern post, and the hangers are of cast steel, and the rudder is forged and of the single-plate type. The hangers are made of two castings, bolted at the center line, being entirely independent of the stern post.

Nine hatches extend through all decks; those in deep tanks being divided by center-line bulkhead and fitted with water-tight steel covers. No. 7 hatch, on shelter deck, is arranged as a tonnage opening. All other hatches are fitted with wooden covers and tarpaulins. In addition to these large hatches, there are a number of small hatches arranged to facilitate the stowage of grain in the wings, also hatches arranged above bunkers for coaling from upper deck.

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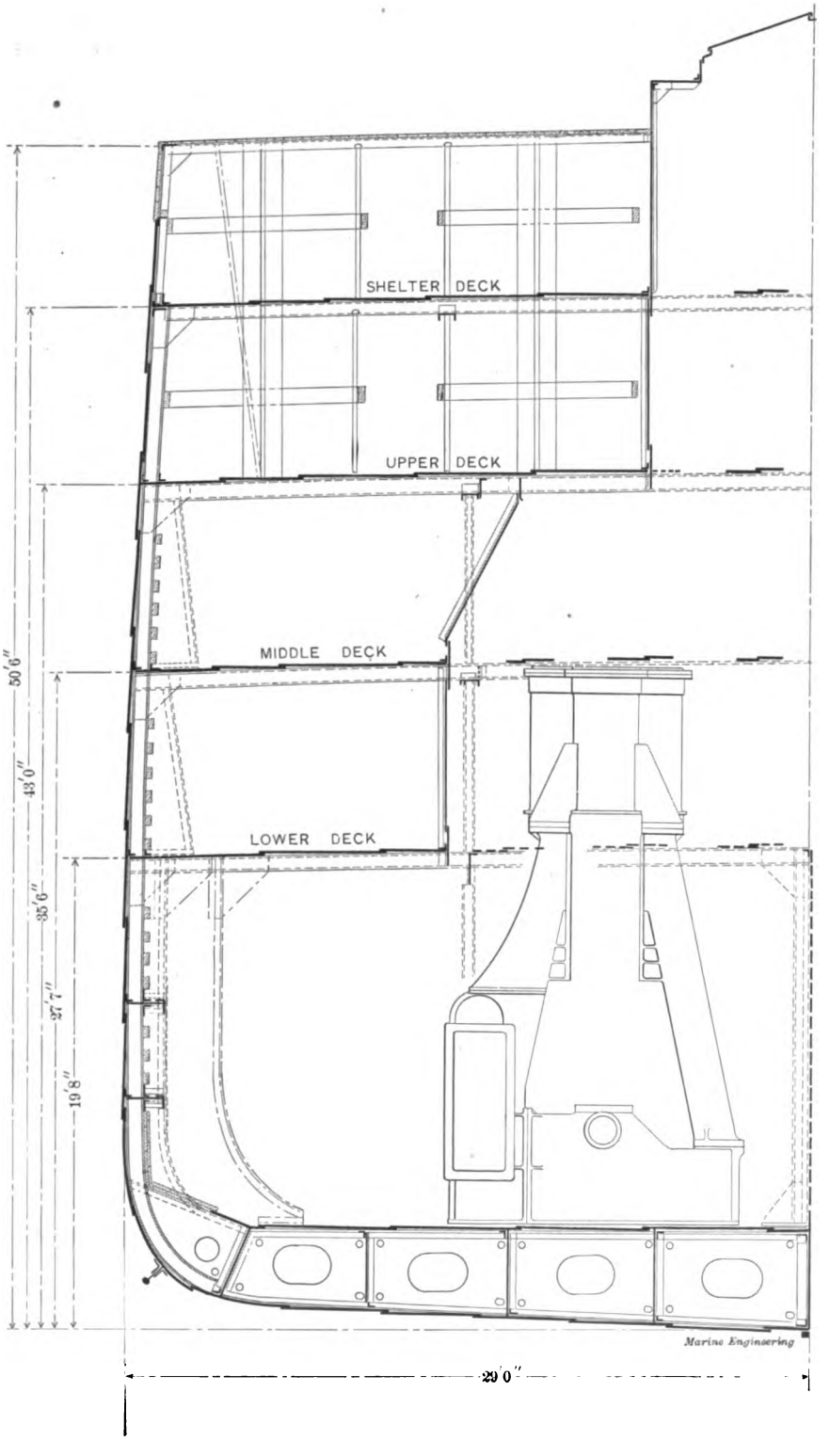
A steel center-line bulkhead is fitted between tank top and lower deck, extending from hatch to hatch, and bunkers are close-ceiled, and wooden sparring is fitted in the hold and in upper and lower 'tween decks. The



MIDSHIP SECTION ATLANTIC TRANSPORT SHIPS MISSOURI AND MAINE, BUILT BY THE MARYLAND STEEL COMPANY, SPARROW'S POINT, MD.

fittings are arranged to take shifting boards in way of hatches, also in lower 'tween decks. The bilges and coal sparring is omitted in deep tanks, as grain is carried in these compartments.

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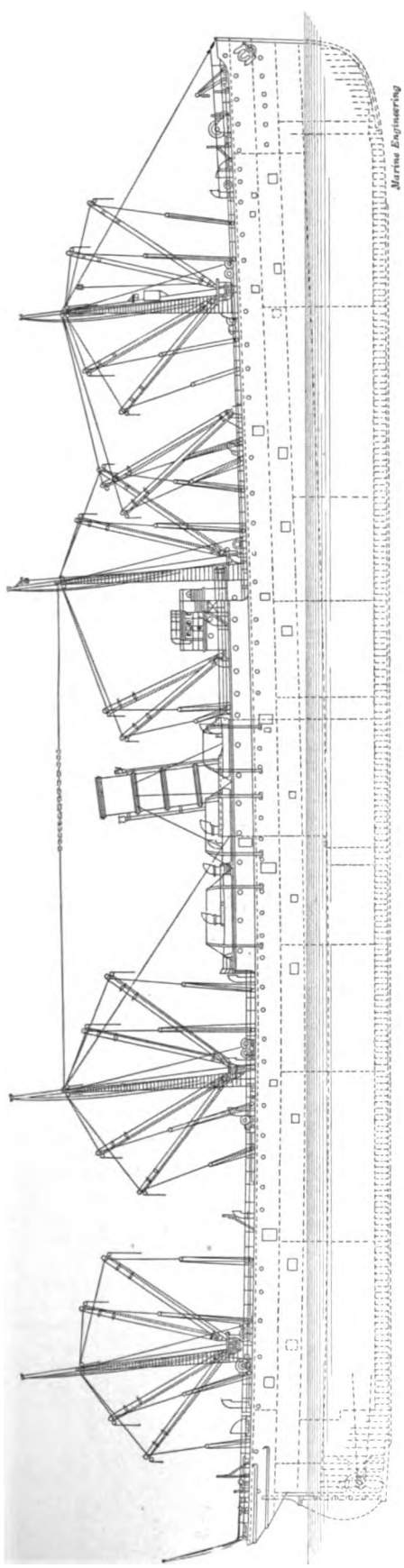

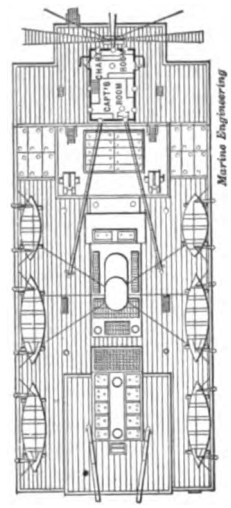

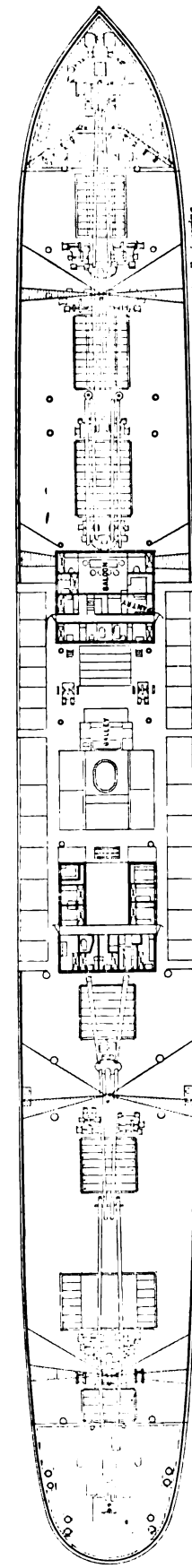

RIGGING AND SHELTER DECK PLANS OF THE NEW ATLANTIC TRANSPORT FREIGHT AND CATTLE STEAMERS MISSOURI AND MAINE.

Between the upper and shelter decks stalls are arranged for 632 cattle, with ports through side for loading and discharging. In addition to these, there is a cattle shelter deck for 125 feet amidships, above shelter deck, with stalls arranged for 118 cattle, making a total of 750 head. The cattle shelter deck is constructed with steel frames and beams and sheathed with 2-inch yellow pine, tongued and grooved. Complete cattle, fresh and salt water service, also fire pipes, steam pipes to winches and steering-gear shaft, are fitted under shelter-deck beams.

There are sixteen winches located on shelter deck, of Hyde make. The after winch has extended heads for warping and relieving tackle. Arrangements are also made to use the forward winch for warping. The windlass is a Hyde No. 13, and is located on the shelter deck, with a 16 by 12 inch engine on deck below. The steering engine, of Wilson and Pirrie type, is being made by

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Harland and Wolff, and will be located on the upper deck, and operated by means of shafting and gears from stands in the pilot house and on shelter deck aft. The anchors, chains, and outfit are fully up to the requirements of Lloyds' rules. An anchor crane is fitted forward, of the government type. The bower anchors are stockless and will be stowed in the hawser pipes.

Four masts are fitted, of sufficient height to carry the cargo booms. On the masts are fifteen booms, three of these being of 20 tons capacity, the remainder of 8 tons. In addition to these there are four booms fitted in deck sockets, two between the fore and mainmast, and two aft of the forward deck house. All booms are of steel, and are arranged to step on tables built on masts.

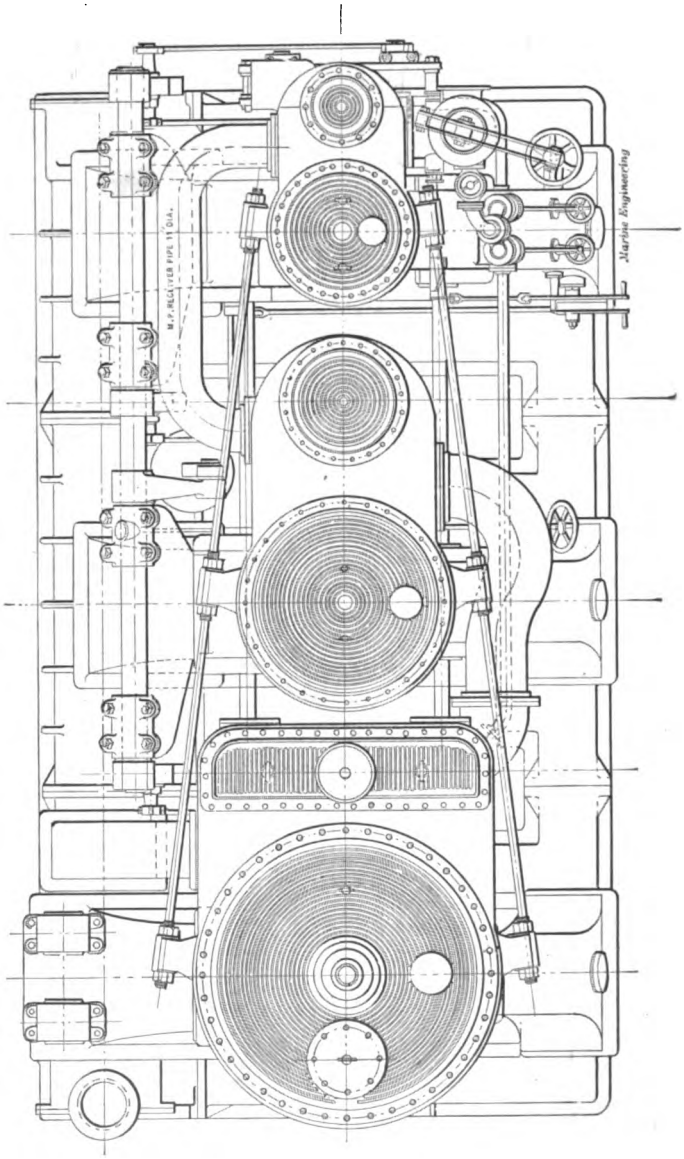
The crew and cattlemen have quarters on the middle and upper decks forward, arranged with pipe berths and being fitted with ample toilets. The ice house and store rooms are located on upper deck on both sides of the steering gear. The captain has commodious quarters in the after end of the chart house. Under the chart house, and contained in a steel house, are the saloon, officers' quarters, toilets, pantry, bonded stores, and state rooms. The engineers have quarters alongside the engine-room casing on shelter deck, and the galley is arranged in the forward end of the boiler casing. The total crew consists of 108 people, and in all departments ample provision has been made for the berthing and messing of this number.

NAME—Missouri.	**NATIONALITY**—American.
TYPE—Freight and cattle steamer.	**LAUNCHED**—
BUILDERS—Maryland Steel Co.	
OWNERS—Atlantic Transport Co.	
Length over all	507 ft.
" between perps.	490 "
Beam, molded	58 "
Depth, molded, to lower deck	19 " 9 ins.
" " middle deck	27 " 7 "
" " upper deck	35 " 6 "
" " shelter deck	43 "
" " cattle shelter deck	50 "
" of water bottom	4 " 2 "
Draft, loaded	27 " 4 "
Displacement, loaded	17,200 tons.
Deadweight	10,400 "
Coal bunker capacity	1,300 "
Designed speed, loaded	12 knots.
Block coef.	.78
Midship section coef.	.97
Wetted surf	46,200 sq. ft.
Engines, number	2
Type	three-cylinder, triple.
Cylinder diameters	25, 42½, 72 ins.
Stroke	48 ins.
Valves	Piston on H. P. and I. P
Air-Pump, diameter	28 ins
Stroke	20 "
Shafting line	14 "
Shafting crank	4¾ "
Condenser	Cast iron in engine frame.
Cooling surf., each	4,375 sq. ft.
Propellers, manganese bronze, number	2
Number of blades	4
Diameter	16 ft.
Pitch	19 " 6 ins.
Developed area	87.6 sq ft.
Boilers, Two double-end, two single-end, Scotch.	
Diameter	15 ft.
Length	19 ft. 1 in.—10 ft. 8 ins.
Working pressure	200 lbs.
Furnaces	3 each end.
Diameter	43 ins.
G. S. total	314 sq. ft.
H. S. total	12,500 "
Draft	Howden system.
Two Sturtevant blowers, diam.	87 ins.
H. S. ÷ G. S.	40

ENGINES.

The twin screws are driven by engines having high-pressure cylinders 25 inches, intermediate cylinders 42 1-2 inches, and low-pressure cylinders 72 inches in diameter, with a common stroke of 48 inches. The cylinders of each main engine are cast separately, and tied together by means of forged steel rods at the top. The H.P. and M.P. cylinders are fitted with a hard, close-grained cast-iron liner and piston valves, and the low-pressure with slide valves worked by Stephenson link motion. The pistons are cast iron, of double section, and provided with Ramsbottom rings of cast iron, carried in removable cast-iron rings, with cast-iron follower rings, held down by large square-headed steel bolts.

The front and back columns are of box section cast iron; the back ones forming part of the condenser. The columns on the starting platform side are to be used as oil tanks, with lock cocks, and pipes leading to the deck. Guide plates of hard cast iron are bolted to each column, with water circulation at back of each go-ahead guide. The columns are tied together at top by forged steel



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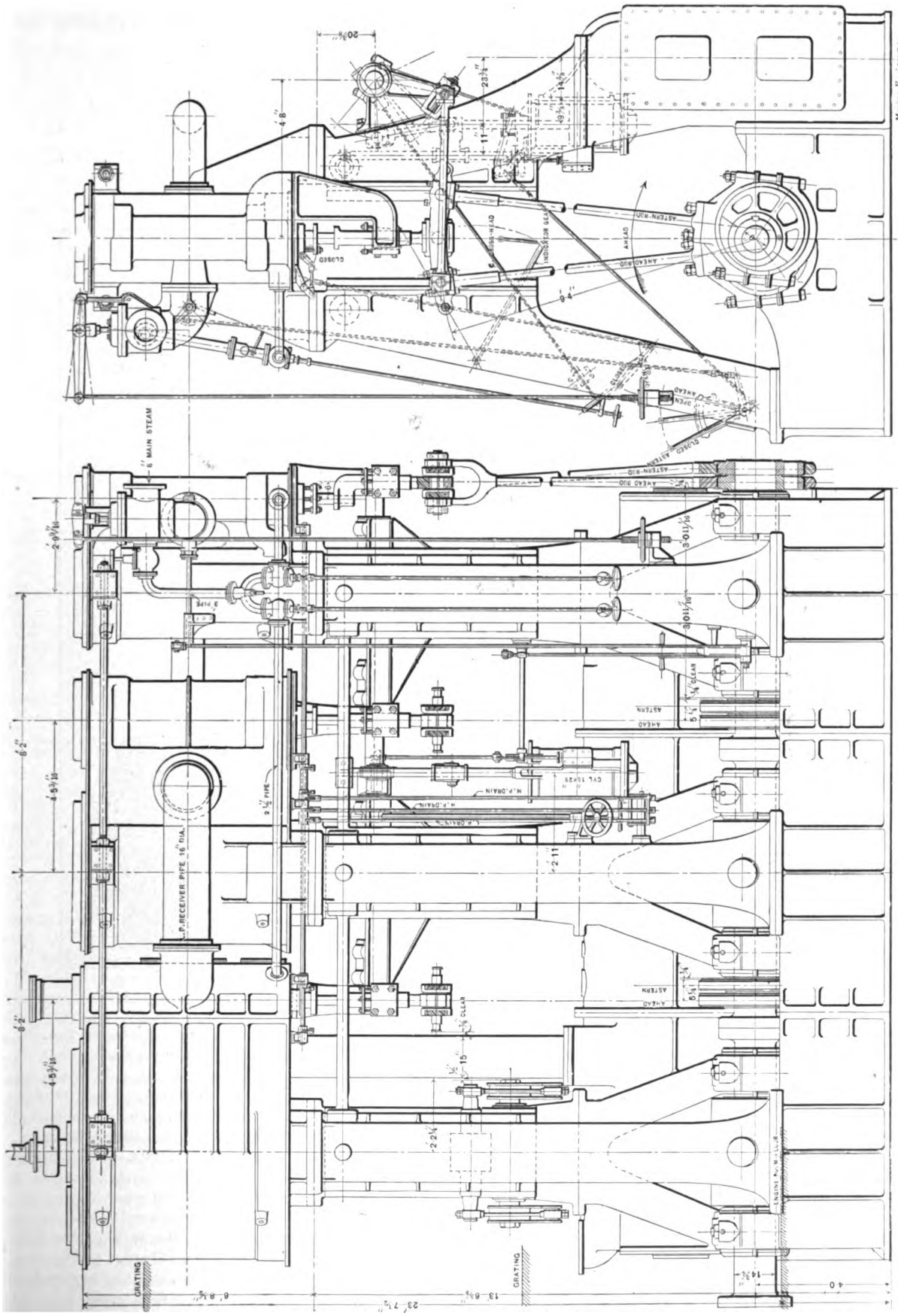

TRIPLE-EXPANSION ENGINE. TWO OF THESE ARE BUILT FOR EACH OF THE NEW ATLANTIC TRANSPORT SHIPS UNDER CONSTRUCTION AT THE WORKS OF THE MARYLAND STEEL COMPANY.

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rods. The condensers are of cast iron, well ribbed, and each has a cooling surface of 4,375 square feet. The bed plate is also of cast iron, of box form, with cross-bearers flanged and bolted to engine seating. The eccentric sheaves are of cast iron, made in halves, with straps of cast steel, lined with Parson's white metal.

The turning engine is fitted between the main engines and connected by means of clutches and gearing to the main shafts. The air and bilge pumps are worked off the low-pressure crosshead, and the fire, bilge, and sanitary pumps are independent and of the Admiralty type. The feed is of Weir type, and all other pumps are made by Blake.

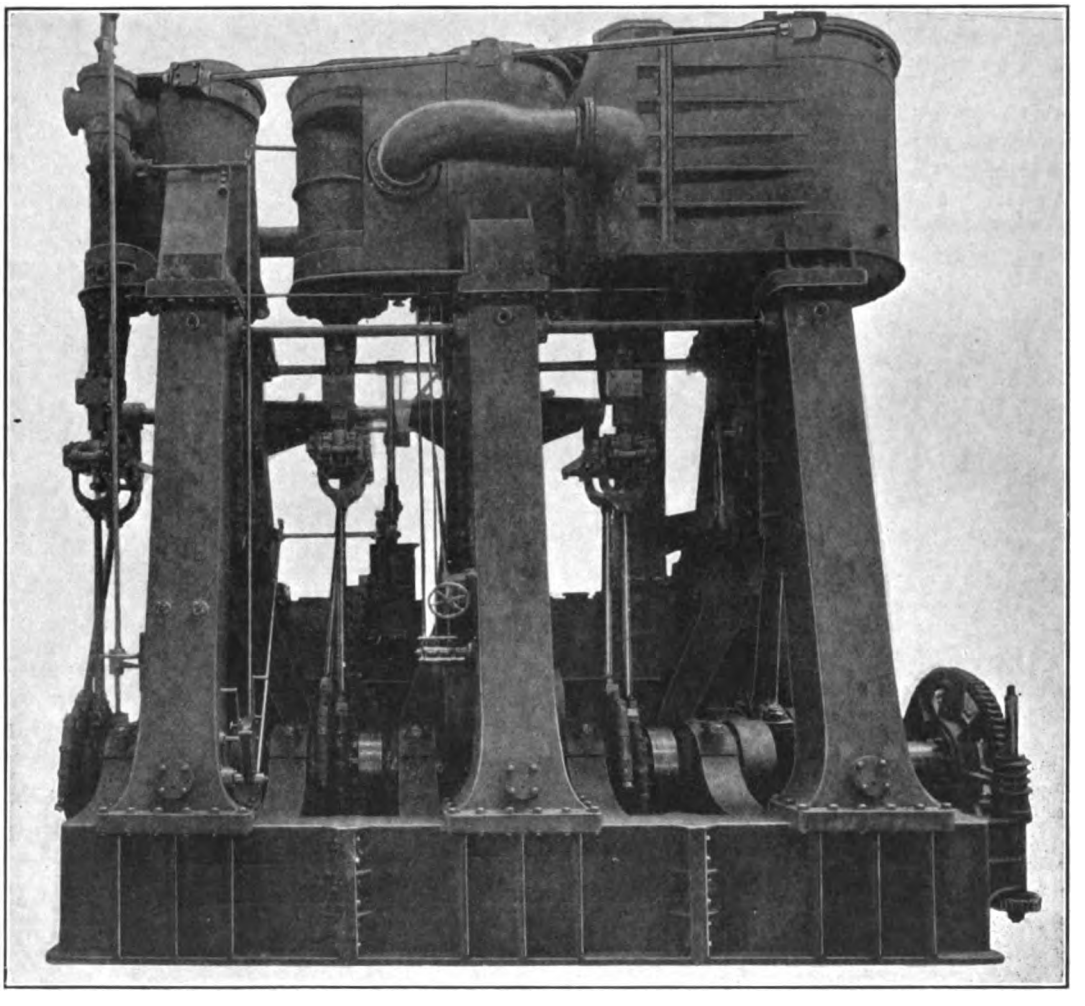
The evaporating plant consists of a Reilly evaporator, with a capacity of 35 tons of fresh water per twenty-four hours, and a distiller of 50,000 gallons capacity per twenty-four hours, together with a feed pump controlled by float in the chest attached to the evaporator. An auxiliary condenser is located in the engine room, and is of ample size to handle the exhaust from all winches, and is connected to a drain tank of ample size.

The shafting is of Siemens-Martin mild-forged ingot steel, in excess of Lloyds' requirements, and is enclosed to the stern tube with plating and frames bossed out to line of large steel casting forward of stern post. The crank shafts are interchangeable.

The stern tubes are of cast iron, the after end being carried by the hanger castings, and the forward end by the stern pipe bulkhead. The propellers are of built-up type, with hub of cast iron and four blades of manganese bronze.

There are two double-end and two single-end boilers of Scotch type, built for a working pressure of 200 pounds. A complete system of Howden forced draft is installed, the fans and engines being located in the engine room. The two Sturtevant blowers, with fans 87 inches in diameter by 24 inches wide, are each driven by a vertical compound single-acting engine 7½ by 13 by 6½ inches. Ash hoists are arranged in each fire room for lifting ashes through ventilator to upper deck. The ship is lighted throughout by electric lights, power being furnished by two 15 K.W. sets of the Sturtevant make.

The accompanying plans give a very good idea of the appearance of these ships when completed. The masts are rather shorter than has been the fashion, but are amply tall for handling derricks. Owing to the fire of the ways under these vessels, as described in October MARINE ENGINEERING, the work has been delayed.



ONE OF THE TRIPLE-EXPANSION ENGINES FOR THE STEAMSHIPS MISSOURI AND MAINE.

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North German Lloyd Steamship Kaiser Wilhelm II.

The speed and size of the great liners of the North Atlantic, which have been continuously increasing since the first days of the steamship, are to be again eclipsed next season by the appearance of the new North German Lloyd express steamship the *Kaiser Wilhelm II.* This ship was launched from the Vulcan Company's yard at Stettin, Germany, last August, and it is expected she will be in service the coming season. A condensed table of dimensions of the latest liners is here given and serves as a basis of comparing the ships of the various companies.

The vessel has a complete double bottom divided into twenty-six water-tight compartments. There are sixteen transverse water-tight bulkheads extending to the upper deck, which is the molded deck, and a longitudinal bulkhead between the engine rooms. The capacity of these compartments is such that if any two of them were filled with water the ship would float. At the stern the framing is bossed out to take in the propeller shafts.

The upper deck is the fourth deck and above it are four other decks, the first being a spar deck right forward and aft. There is a forecastle, a midship house, and poop. The roof of the midship deck house extends over the full width of the ship and over the poop, forming an upper promenade deck 538 feet long. On this deck is built the upper promenade deck, 438 feet long, and over this is the boat deck.

A complete system of fire alarm bells is provided, as is also a complete fire-extinguishing installation. There are fifty-two water-tight doors in the bulkheads, and twenty-four of them are provided with the Dörr closing device by means of which they may be shut from the bridge. A bulkhead indicator in the chart house shows whether the doors are open or closed. When it is desired that the doors be closed from the bridge, alarm bells throughout the ship are sounded for twenty seconds previous to the closing. The doors may also be operated separately from each bulkhead.

The *Kaiser Wilhelm II* will have accommodations for 775 first-class passengers in the 290 cabins; 343 second-class passengers in 102 cabins; and 770 passengers of the third-class are carried on the main and lower decks. The ship's complement consists of 48 in the engine room, 229 in the boiler room, 231 in the stewards', and 45 in the deck department, making a total of 2,418 souls carried.

Of the many features of the first-class cabin are two very specially comfortable rooms called imperial suites, eight rooms de luxe, eight state rooms, and four chambers with separate baths and closet. The imperial suites consist of a saloon, breakfast room, sleeping room, and bath room, located on the upper promenade deck. The main dining saloon, which has a seating capacity of 554 passengers, is on the main deck, and the smoking room, reception room, reading and writing rooms are located on the upper promenade deck. On the boat deck are the children's room, café, and grill rooms. The second-class passengers are accommodated on the upper, lower, and main decks, aft. These cabins follow the lines of those of the first-class, except that they are not quite so elaborately decorated. The dining saloon, with seats for 190 persons, is on the main deck; reception and smoking rooms are at the after end of the promenade deck. As it is necessary to provide meals for so many people, very elaborate kitchens and pantries are to be found on board for the first and second cabins and the third-class passengers.

The ship has been built with a view of mounting, if necessary, a large number of guns in order to serve as an auxiliary in the Imperial German Navy. The deck equipment is of the very best and includes warping capstans, windlasses, etc. The launching weight of this ship was 11,200 tons, which is 1,900 tons greater than any other German ship launched.

	Builder.	Owners.	Length Over All.	Breadth.	Depth, Molded.	Gross Tonnage.	Draft.	Displacement.	Indicated Horse Power.	Highest Speed.
Kaiser Wilhelm II	Vulcan and Co.	North German Lloyd	706 ft. 6 ins.	72 ft.	52 ft. 6 ins.	20,000	29 ft.	26,000 tons.	38,000	24 knots.
Kronprinz Wilhelm	"	"	663 "	66 "	43 "	15,000	29 "	21,300 "	36,000	23.5 "
Deutschland	"	Hamburg-American	684 "	67 "	44 "	16,502	29 "	23,620 "	36,000	23.5 "
Kaiser Wilhelm der Grosse	"	North German Lloyd	648 " 7 1-2 ins.	66 "	43 "	14,349	28 "	20,880 "	30,000	23 "
Oceanic	Harland and Wolff	White Star	704 "	68 " 5 ins.	49 "	17,274	32 " 6 ins.	28,500 "	27,000	20.7 "
La Lorain and *La Savoy*	.....	Transatlantic	582 "	60 " 6 "	39 " 4 1-2 ins.	11,869	25 " 6 "	15,400 "	22,000	21.9 "
St. Paul and *St. Louis*	Cramp	American	554 "	63 "	42 "	11,629	26 "	16,000 "	18,000	21.08 "
Campania and *Lucania*	Fairfield Company.	Cunard	622 "	65 " 3 ins.	41 " 6 ins.	12,500	25 "	18,000 "	30,000	22.01 "

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PROTECTION OF PROPELLER AND STERN-TUBE SHAFTS.

BY JOHN J. KING.

The protection of propeller and stern-tube shafts from galvanic action is a question which has engrossed the attention of engineers on account of the numerous failures of these parts without apparent cause.

In order to do this successfully some covering must be provided which will positively exclude the salt water from coming in contact with the shaft.

This is sometimes attempted by means of a loose tube or pipe of copper or brass slipped over the shaft, the ends butting against the composition sleeves on the shaft which form the bearings at stern tube or struts, the joints being sealed by a ring of soft solder.

Sometimes the composition sleeves are recessed and the joints made to overlap the tube and sealed, as in Fig. 1.

These are, however, very doubtful methods, as the soft solder will not last in salt water, but will soon be eaten away, thus leaving a free entrance for the water at the joints.

The writer has seen four stern-tube shafts, which were fitted like the first-mentioned method drawn, for examination, and in every case the solder was broken and cracked away from the composition bearing sleeve at the forward stern-tube bearing, leaving the joints open and water free to enter between the shaft and the tube forming the casing.

The breaking of the joint in this case was not due, however, to galvanic action, the vessels not having been afloat a sufficient length of time, but either to the difference in expansion of the shaft and sleeve covering, the "wringing" of the shaft, or in the handling in placing the shaft aboard.

In making the repairs to this casing the stern-tube bearings were drilled at *A* and *A*[1], Fig. 1, where they overlapped the casing. One end was then tapped to receive 3-8-inch pipe, and turpentine was pumped into the space between the shaft and its casing, running in at one end and out at the other until thought to be cleaned. Then one end was plugged, the bearing sleeves were calked down on the brass casing tube at the joints, and red lead putty was pumped into the space between the shaft and casing, the joint being finally sealed by a fillet of tin.

Another case which came to the writer's notice had the shaft covered in the stern tube by short lengths of brass tube, which were very likely soldered at the joints when first put on the shaft, but the joints were open when seen after the shaft broke. The engine at the time was running full speed ahead, with the pass-over to the low pressure open wide. The engineer had left the engine room when the shaft broke, and before the throttle was closed the cast-iron housings were broken top and bottom and a couple of the cylinder feet cracked.

A method usually employed on naval vessels is to cover the shaft with sections of short composition sleeves, as shown in Fig. 2, cast in lengths of 4 to 5 feet, which are shrunk on the shaft, the joints overlapping each other. Methods of making these joints are shown in Figs. 3, 4, and 5.

When the sleeves are rough turned sufficient metal

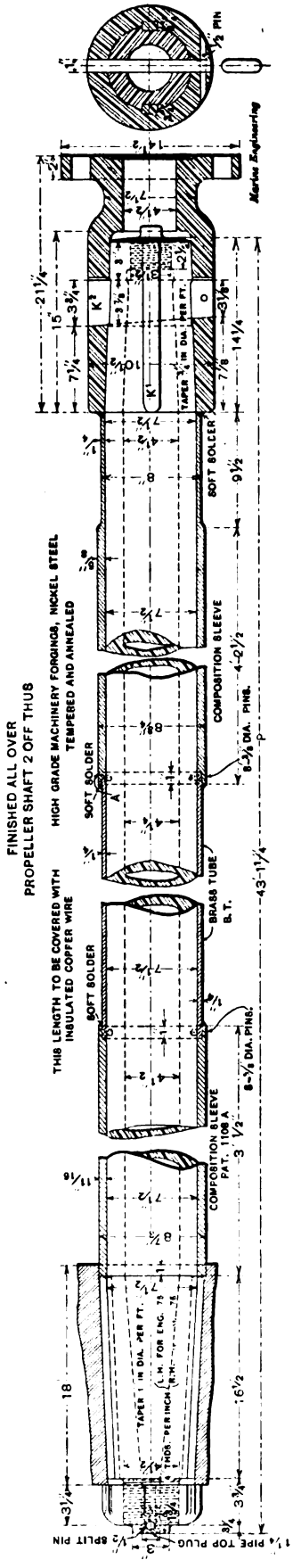

FIG. 1.

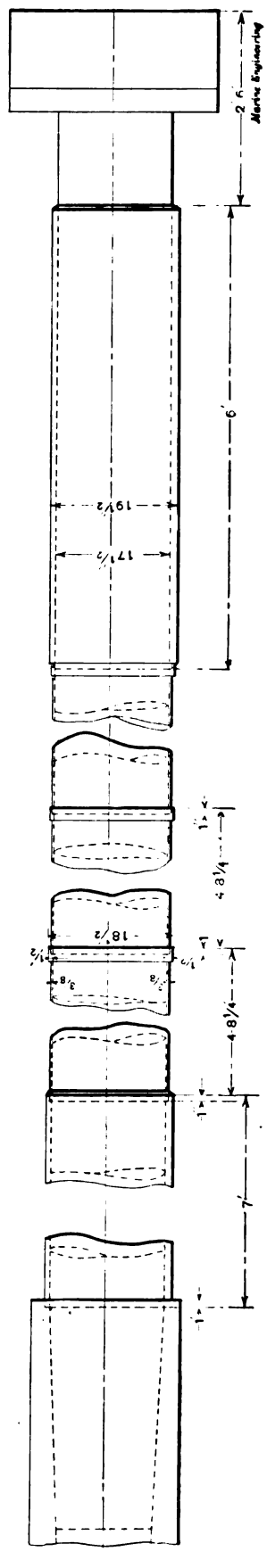

FIG. 2.

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should be left to calk down and fill the recess between the joints caused by one sleeve shrinking away from the face of the sleeve next to it in cooling after being placed on the shaft. All iron chaplets in sleeves should be drilled out and plugged before being shrunk on. The after-bearing sleeve should make a water-tight joint with the propeller hub. Care should be taken that the keyways in the hub of the propeller do not extend deeper than the bottom of the recess at the forward end of the hub made to receive the shaft-bearing casing, as the water would then have a chance to run over the top of the key and thus reach the shaft. The same precaution should be taken in all outboard sleeve couplings, although these usually have a casing which is filled with rosin and pitch.

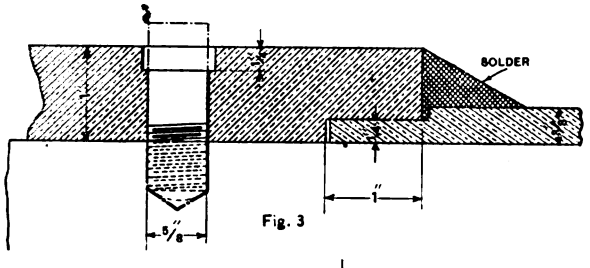

Fig. 3

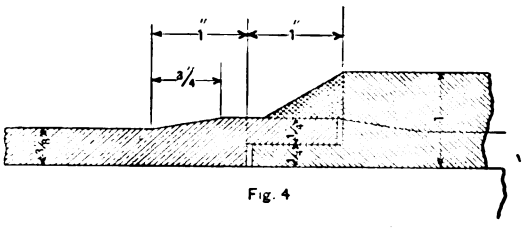

Fig. 4

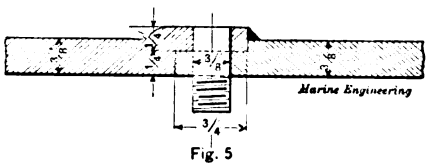

Fig. 5

The shell of the ship and stern tube is sometimes protected from the galvanic action due to these sleeves by serving the exposed composition with insulated copper wire or tape.

When the shafts are being placed aboard every joint should be examined before entering the stern tube, and if found cracked or open, which is likely to occur in handling if the shafts are long, they should be remedied.

President Roosevelt's Message.—In his annual message to Congress President Roosevelt makes a very earnest plea for the navy, recommending that the appropriation for gun practice be increased, as the only shots that count in battle are, he says, "the shots that hit." The lack of men and officers for the ships is also a serious question. In regard to increase of the navy, he recommends that there be no halt in the number of new vessels added each year, as the Isthmian Canal, while increasing the efficiency of our navy, will also require a larger-sized fleet. Although there is at present not the slightest chance of trouble with a foreign Power, the way to insure peace is to provide a thoroughly efficient navy.

RUNNING LIGHTS AND TELL-TALE DEVICES.

BY GEORGE MCQUILKIN, JR.

Since the safety of navigation depends at night on the continuous display of the running lights (that is, the side lights, masthead light, and sometimes the stern light, range light, towing lights, and the anchor light), it is necessary to give attention to these lights at frequent intervals in order that they may be continuously displayed. The ordinary types of lanterns are fitted with one or two lamps, to each of which is connected a double conductor cable through the medium of a receptacle, each lamp having its respective receptacle and switch, combined or separate, and a fuse, all of which are generally located near the lantern. The objection to the single lantern having only one lamp is that it requires more attention so that the lamp will not be extinguished for any appreciable length of time, and the delay in replacing the faulty lamp, while the objection to the double lamp is the impossibility of detecting when one lamp has been extinguished, except by close inspection.

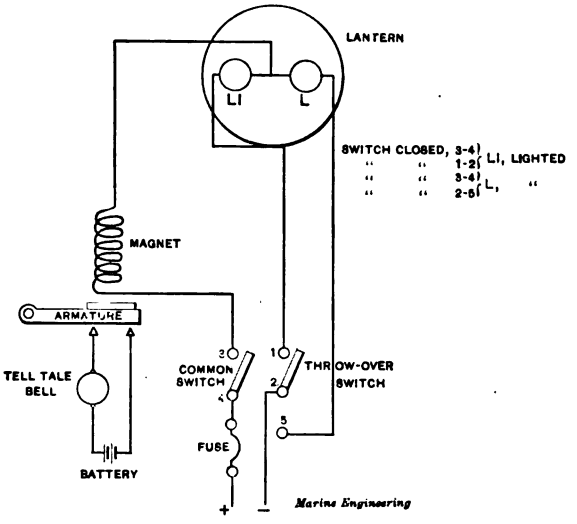

FIG. 1.

To avoid the necessity of attention and to afford a means of detecting when one lamp is extinguished, and to restore the lighting as quickly as possible, the following devices have been designed: The main features of the lanterns are the use of two lamp receptacles. One form has two receptacles on a filled wooden block mounted on the removable bottom of the lantern, and another type has two radial arms fitted so that the lamp may be brought out into the proper position in the lantern—that is, into focus with the lens, access to the lamps being had through a door on the side of the lantern. The latter type is probably the most endurable, being of metal parts, whereas in the former type the filled wooden block is likely to absorb moisture and swell, and therefore be difficult of removal from the case. Again, the block may be cracked by moisture, rendering it unfit for use. A good substitute for the wooden block is a composition plate raised to the same height as the wooden block, insulation being obtained by hard rubber inserted at the proper point.

The elementary diagram of wiring is shown in Fig. 1,

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and is the principle of all the devices described. The lanterns each contain two lamps, and are fed from this device, which is generally located near the steering wheel station, through two switches. One is a single-throw switch common to all lamps, and the other a double-throw switch for each lantern. One clip of this double-throw switch is connected to one lamp, and the other clip connected to the other lamp, in the same lantern, so that when this switch is thrown up or down the lamp connected to the clip in contact is lighted and the other lamp extinguished. In the common wire, connected to the common switch, an electro-magnet is supplied by the current feeding the lamp, so that when either lamp is burning the magnet is energized and its armature attracted. When the current fails, due to the extinguishing of a lamp, the armature falls and makes contact with two points, thus closing the circuit connected to a bell or lamp, and indicating audibly or visibly until the current is sent through the magnet again. This can be accomplished by throwing the double-throw switch to the other position, when the extra lamp will be lighted, the magnet energized, and its armature attracted, thereby opening the bell or lamp circuit, which indicates that the lamp is burning. The burned-out lamp can then be replaced at convenience. In Fig. 1 the bell is shown operated by a battery. This is to be preferred, because if it were operated from the dynamo current and it failed there would not be power to operate the tell-tale bell or lamp. When a battery is used a switch is provided, so that the battery may be disconnected during the day in order that the bell may not run down the battery.

The type of device that the above description closely applies to is shown in Fig. 2. Another type that combines the audible and visible tell-tale is shown in Fig. 3. Assume that the lamp, *L*, Fig. 3, is burning, then current will flow from positive side through magnet, attracting its armature, thence to *Y*, to *X*, to lamp *L*, to 5 (switch is now closed across 2 to 5), to 2, to negative side. Lamp *L*1 will not burn, as its switch, 1 to 2, is open. The armature of the magnet will continue to be attracted as long as the current flows through lamp *L*; but if this lamp should be extinguished, then the current will cease flowing through the magnet, and its armature will be pulled by a spring until it strikes a point, *P*, and then the circuit is completed from positive, through magnet, to *Y*, to *X*, to *P*, through tell-tale lamp, to 2, to negative side. This lights the tell-tale lamp and attracts the armature of the magnet; but when the armature is attracted it breaks the circuit at *P*, and as the magnet is no longer energized, the armature is returned to *P* by the spring and the operation repeated. This making and

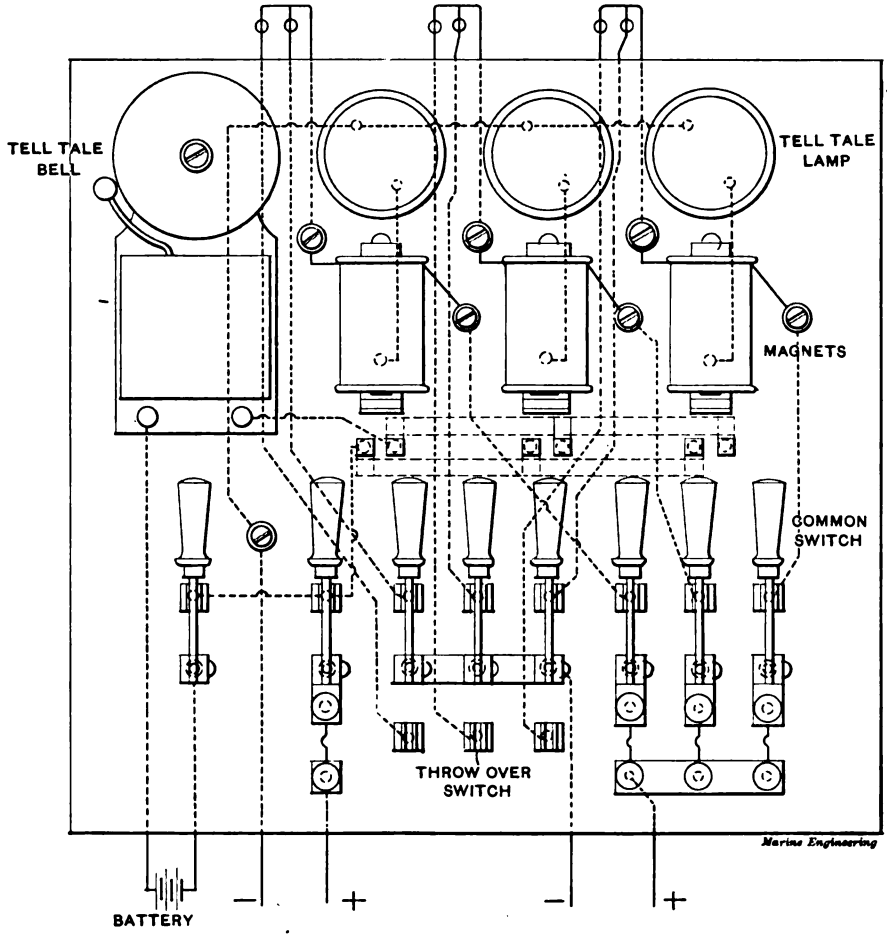

FIG. 2.

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breaking of the circuit at *P* is very rapid, and causes a buzzing sound, giving the audible signal, and the tell-tale lamp, lighting each time the circuit is closed at *P*, gives the visible signal. It is obvious that if the dynamo current failed there would not be any signal given, as both the audible and visible tell-tales depend on the dynamo current for their operation, thereby rendering the tell-tale ineffective.

The snap switch is shown in the same side of the circuit as the throw switch. A better arrangement would be to connect the snap switch in the opposite side of the circuit, so that by opening the circuit at both of the switches the line to the lamps would be "dead." One type of device similar to the above, but using a single lamp, omits the throw-over switch, but retains the snap switch and adds the plug switch, so that, when the lamp is burning, by removing the plug the lamp may be tested, and this also secures the entire disconnection of the circuit from the device to the lantern. The double lamp is to be preferred, for the reasons stated above.

A double-lamp type of device retains the audible and visible signals, and also automatically replaces the extinguished light. Each lantern is fitted with two 32 c. p. lamps, and three wires are run from the indicator to the lantern. Under the indicator are fuses and switches for each lantern. All the lanterns are wired in a similar manner, and only the starboard lantern will be described. As the switches are turned on, lamp 1, Fig. 4, receives the current, and the magnet *M* is energized, lifting its armature, which carries the shutter, and the word "Burning" appears in its respective place on the face of the indicator. This leaves one lamp at this station in reserve. If lamp 1 is extinguished, or if the candle power is reduced, the indicating shutter for this lantern will show the word "Out," which means that the lamp 2 has been brought into the circuit, and this is further indicated by the vibrating of the alarm bell, and the tell-tale lamp over the instrument lighting up. The ringing of the alarm bell may be stopped by switching off the tell-tale lamp or by replacing lamp 1. This device is also fitted with a mechanical bell below the magnet *M*. The clapper for this bell is fastened to the armature, and in case of failure of the current supply the armature falls, and the clapper strikes the bell, giving the alarm; in which case the word "Out" appears on the face of the indicator.

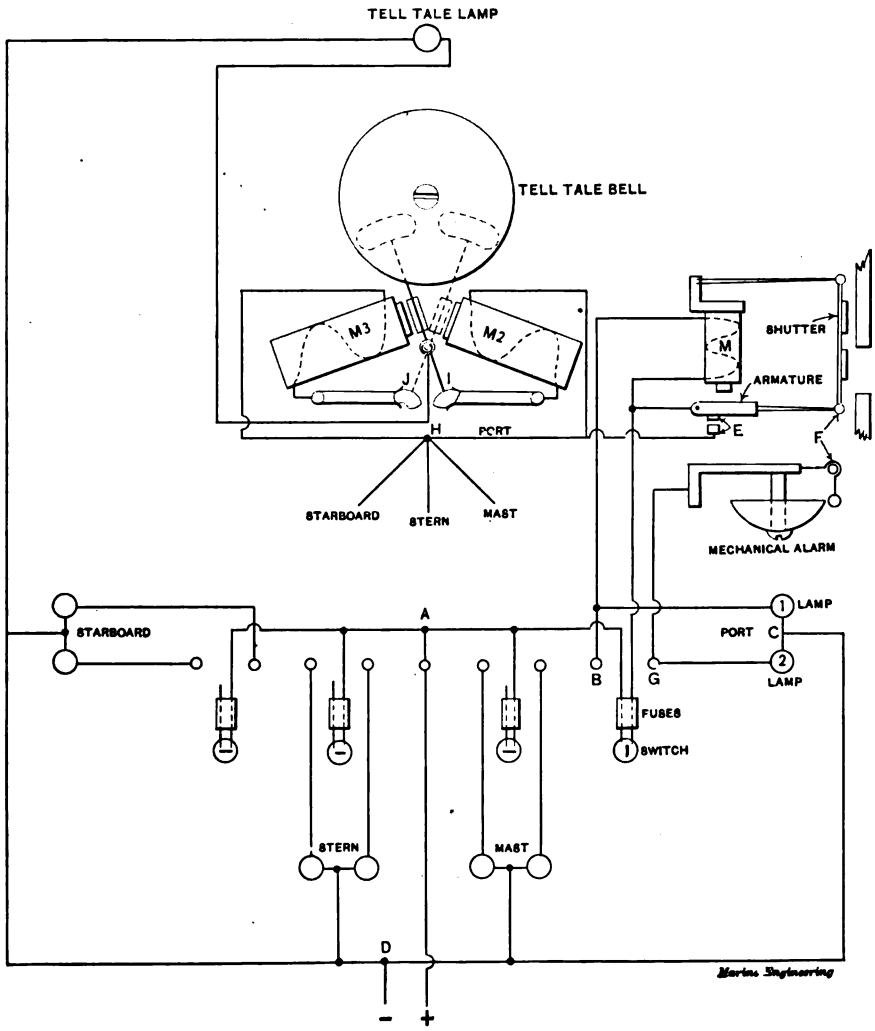

FIG. 4.

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The wiring, Fig. 4, is shown for the starboard lantern, and is as follows: Starting at the positive side, to *A*, to fuse, to switch, through magnet *M*, to *B*, to lamp 1, to *C*, to *D*, to negative side, completing the circuit through the magnet *M* and the lamp 1. Magnet *M* lifts the armature, opening the circuit at *E* (leaving lamp 2 in reserve), which remains open until lamp 1 is extinguished. When lamp 1 is extinguished, armature drops and closes the circuit across *E*, and current flows from *E* to *F*, to *G*, through lamp 2, to *C*, to *D*, to negative side, and lighting lamp 2. Current also flows from *E* to *H*, through magnet M_1 (attracting armature of tell-tale bell), to *I*, through tell-tale lamp, to *D*, to negative side, lighting the tell-tale lamp. Armature of tell-tale bell is attracted

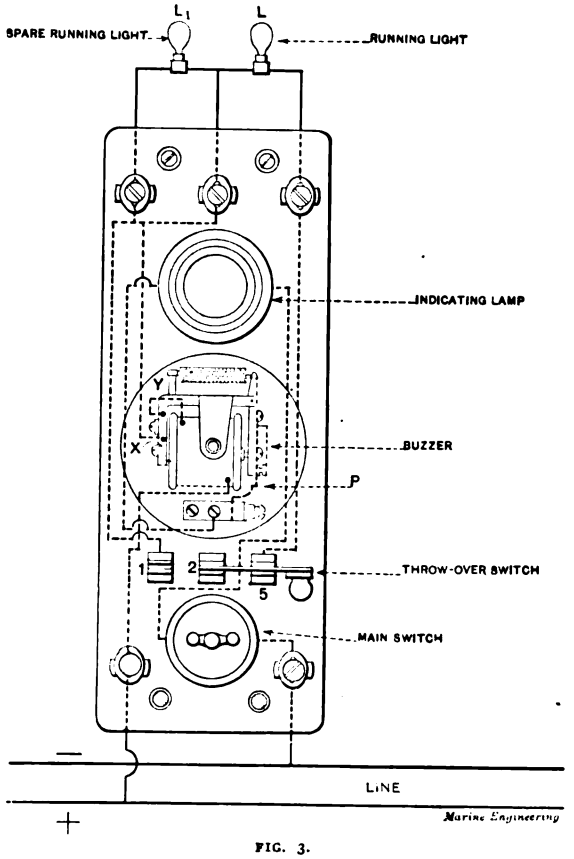
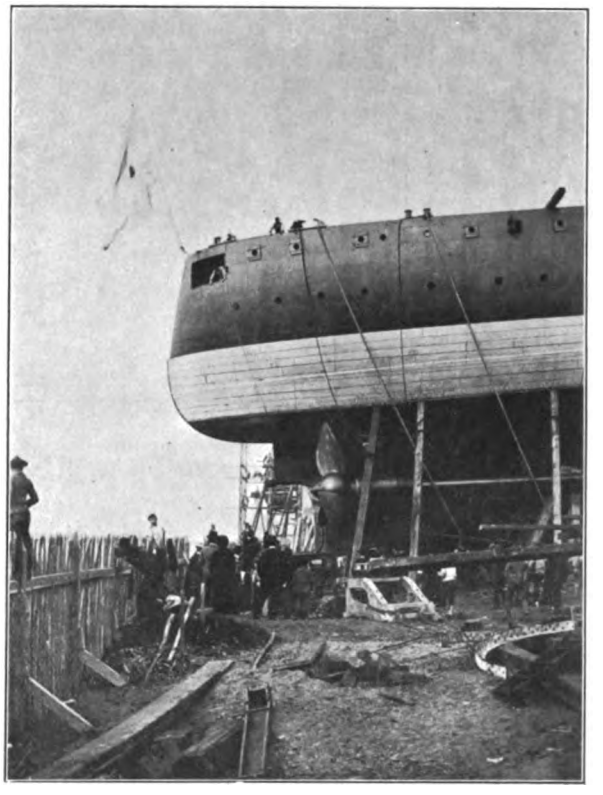


FIG. 3.

by magnet M_2, and is drawn into the position indicated by the dotted lines, and in moving to this position breaks the circuit at *I*, cutting out magnet M_2, and closing the circuit at *J*, sending current through magnet M_3, which attracts the armature in the same manner as magnet M_2, causing the vibration of the bell-striker. The action is similar to that in the case of the buzzer, Fig. 3. It is obvious that if lamp 1 were replaced, that magnet *M* would again attract its armature and open circuit at *E*, and stop bell ringing; or if it is not desirable to immediately replace lamp 1, the bell could be stopped by turning off the tell-tale lamp, which would open the circuit through the tell-tale bell. Obviously, then, if the tell-tale lamp were turned off, the circuit through the tell-tale bell would be open, and if another lamp burned out the tell-tale bell and lamp would not give a signal. The signal given would be the single stroke of the mechanical alarm when the armature dropped, and in case the extra lamp in the same lantern was extinguished no signal would be given, as the armature had already dropped for that lantern.

It is to be noted that in each type the magnets are supplied by the lamp current, and care should be taken that lamps of 32 c. p. are used in the lanterns, otherwise the magnets may not be energized sufficiently to attract their armatures—a 16 c. p. lamp consuming only one-half the current required by a 32 c. p. lamp.



STERN OF ARGENTINE BATTLESHIP RIVADAVIA.

Battleship Rivadavia, for the Argentine Republic.

Accompanied by interesting ceremonies, the battleship *Rivadavia* was launched from the yard of Messrs. Ansaldo and Company, Genoa, Italy, on October 22. Preceding the launch, the Catholic custom of dedicating the ship was observed by the Archbishop of Genoa, who pronounced a benediction on the vessel as she was about to go overboard. The keel plate was laid for this vessel March 10, 1902, making a record for quick work. In the accompanying table will be found the principal dimensions.

The armor encloses a central redoubt, extending for half length of the ship, of 6 inches thickness on the sides and 4 3-4 inches at the ends. The side belt extends 5 feet above the water line and the same distance below the water line, and outside the redoubt the side armor tapers to 3 1-8 inches at the ends. On the upper deck are two barbettes of 5 5-8-inch armor, one forward and one aft. The conning tower has 4 3-4-inch armor:

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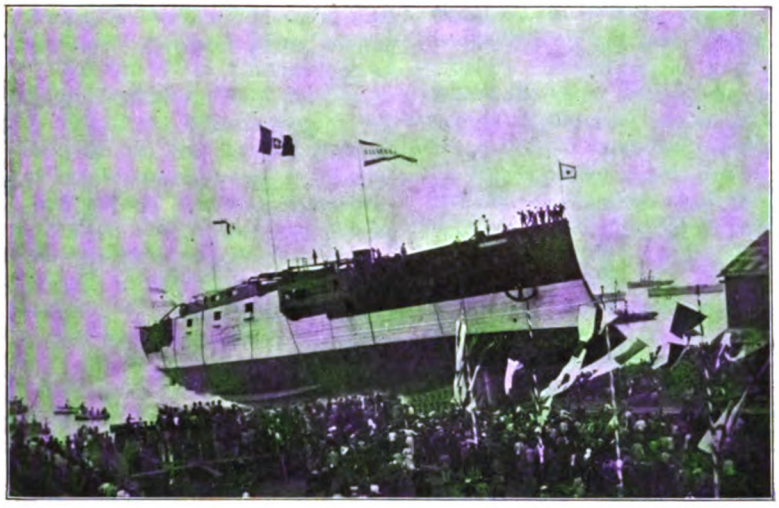
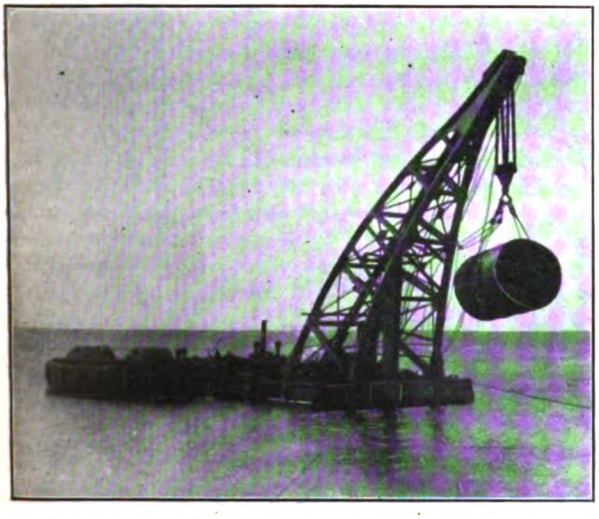
the protective deck is laid in two thicknesses of 1 5-8-inch plates.

The armament comprises one quick-firing 10-inch gun placed in the forward barbette, two 8-inch guns in the after barbette, and fourteen 6-inch rifles. The secondary battery includes ten 3-inch R.F.G., two automatic Maxim guns placed in the military tops, and four above-water torpedo tubes.



LAUNCHING OF THE BATTLESHIP RIVADAVIA AT GENOA, ITALY, FOR THE ARGENTINE REPUBLIC.

A complete double bottom is fitted and under the machinery is divided into 44 water-tight compartments. The total number of water-tight compartments formed



FLOATING DERRICK WITH THE RIVADAVIA'S BOILER.

by the double bottom, transverse and longitudinal bulkheads is 250.

The motive power consists of two 3-cylinder, inverted, direct-acting, triple-expansion engines of dimensions given in the table. Steam is supplied at 165 pounds by four single-end and four double-end Scotch boilers. The two main engines are separated by a longitudinal bulkhead, the boilers are arranged in two compartments forward and two aft. Forced draft is applied to the ashpits. The steam piping, which is of steel with cast-steel bends, comprises two main lines laid along each side of the vessel to the engine room and so fitted that both engines may be supplied from one or the other lines.

Electricity for lighting and power is provided by five 35-K.W. generating sets. The electric drive will be used for the guns, ammunition cars, and for many auxiliaries. The steering engines are of the Roger type, and the stockless anchor is of the Hall type. The estimated speed of this vessel is 20 knots, and the maximum coal supply of 1,100 tons will give a radius of action of 9,000 miles at 10 knots. Very little wood has been used in the construction.

The principal dimensions are:

Length over all	357 ft.
" between perpendiculars	344 "
Extreme beam	61 " 4 ins.
Depth	40 "
Mean draft	24 "
Displacement	7,700 tons
Launching weight	2,800 "
Engines, type	triple expansion.
Cylinder, diameters	42 1-2, 63, and 92 3-4 ins.
Stroke	46 "
Boilers, number	one-double end; two single-end.
Steam pressure	135 pounds
G. S.	893 sq. ft.
H. S.	24,272 " "
Condenser surface	6,910 " "
Designed I. H. P.	13,500
Estimated speed	20 knots

Testing the Hull of a Torpedo Boat.—The British Admiralty is experimenting with the torpedo-boat destroyer *Wolff*, to learn if she has sufficient strength to withstand the hogging and sagging strains received in the seaway. The torpedo-boat destroyer has been placed in dry-dock and lifted by a specially-built cradle at each end, the center being unsupported. The cradle was then placed amidships and the vessel raised clear of the ends. No defects were brought out, and the vessel will be taken to sea for further experiments.

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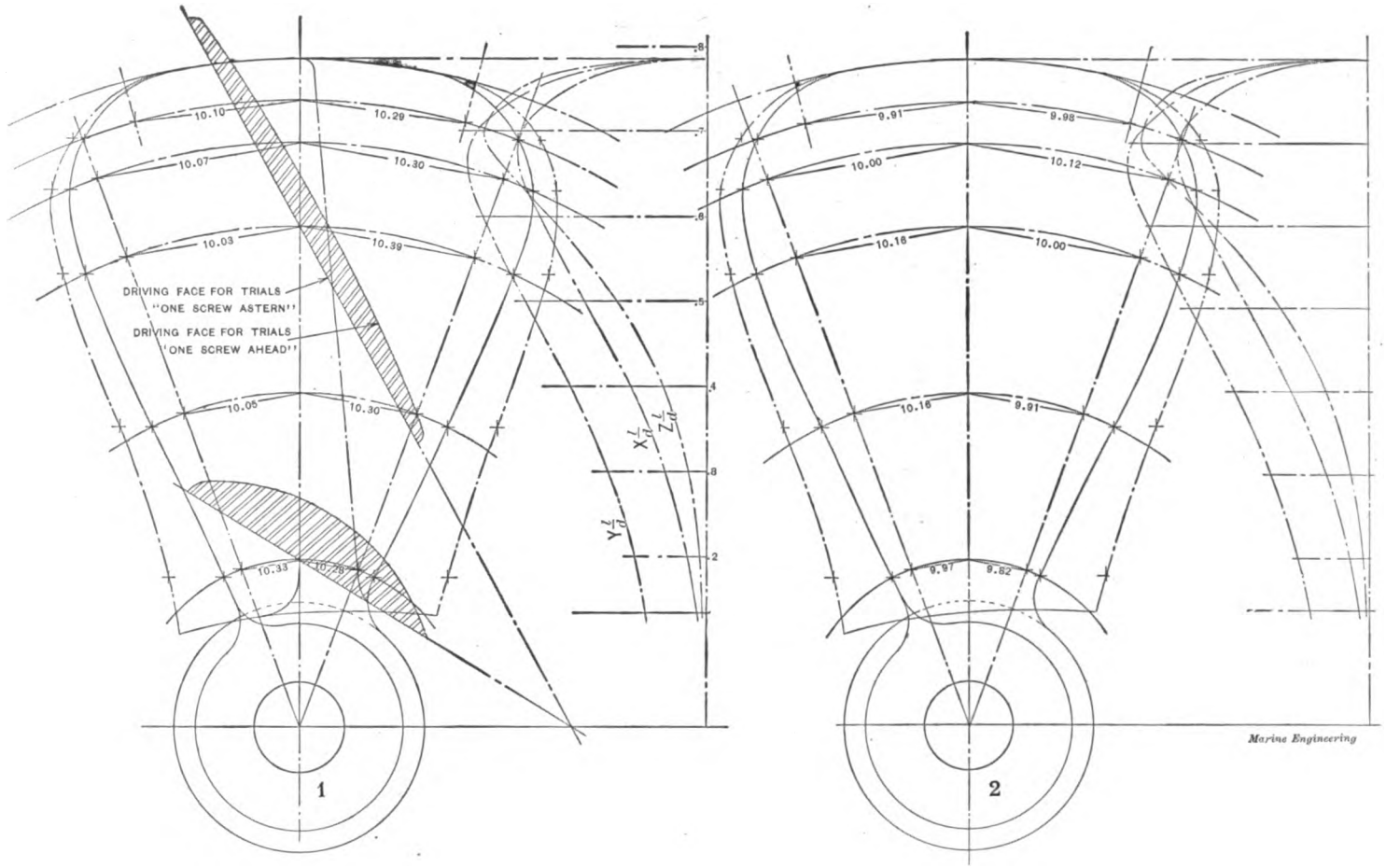

Used in Both Single Screw Trials.
Stern Screw in Trials with Both Screws in Action.

EDGEWATER.

FOUR-BLADED CAST-STEEL PROPELLERS.

Bow Screw in Trials with Both Screws in Action.
This Screw Driving with Back of Blade.

	1	2
Disc area	50.27 sq. ft.	50.27 sq. ft.
Boss "	1.77 " "	1.77 " "
Developed "	31.98 " "	31.89 " "
Projected "	26.40 " "	26.37 " "
Pitch as measured	10.19 ft.	10.03 ft.
" " designed	9.75 "	9.75 "
Diameter	8.00 "	8.00 "

Contour and Pitch Measurements Are the Mean for All Four Blades.
Thickness Measurements from One Blade of Each Wheel, Averaged.

Taylor's Characteristics.

Scale for X & Y, $1'' = \frac{4}{10}$. For Z, $1'' = 2.\dot{1}$

	1	2
Area $X\frac{1}{d}$ curve	17.64 sq. in.	18.01 sq. in.
" $Y\frac{1}{d}$ "	27.21 " "	27.50 " "
" $Z\frac{1}{d}$ "	15.93 " "	16.69 " "
Value of X_c	.147	.150
" " Y_c	.227	.229
" " Z_c	.664	.695

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PROGRESSIVE TRIALS OF THE SCREW FERRY-BOAT EDGEWATER.*

BY EDWIN A. STEVENS, VICE-PRESIDENT, AND CHARLES P. PAULDING, JR.

The only excuse the authors can give for the presentation of the results of the trials of the *Edgewater* is the value of data of this class to designers.

Three sets of trials were run—1st, with one screw astern; 2d, with the same screw ahead; 3d, with both screws.

Similar trials, as far as the authors are aware, have been run in but two other instances—those of the *Bergen*, recorded in Vol. XI. of the Transactions of the Society of Mechanical Engineers, and of the *Cincinnati*, recorded in Vol. IV. of the Transactions of this Society. Of the former it can only be said that, as their main object was the determination of steam consumption, the speed data did not receive enough attention to insure reliable results. The trials of the *Cincinnati*, however, were most carefully run.

The result of the greatest interest in the *Edgewater's* trials is the low resistance of the hull as compared with similar vessels. Full speed in ordinary service is about 10 1-2 knots.

The following is the approximate performance of several vessels of this class at about that speed:

Name.	W. L. Length.	Displacement.	Block Coef.	Slip.	Adm. Coef.
Bremen	217	900	.34	16	154
Cincinnati.	200	952	.42	18.5	133
Netherlands	203	825	.36	18.5	144
Edgewater	173	687	.42	14.5	173

The above data are close approximations only. It is to be remembered that low resistance is not as important in these vessels as in most others, and may well be sacrificed to other elements of design. It is also to be remarked that the trials of the *Bremen, Cincinnati,* and *Netherlands* were run with screws since shown to have been of unsuitable design. Notwithstanding this fact, the authors would call attention to the close relation between slip and performance in these vessels. The similarity between the curves of Admiralty coefficient and of slip in the *Edgewater* is specially marked.

In the following appendix are given a description of the vessel, an account of the trials, and the method of observation and calculation. The tables attached give a full log of the trials:

APPENDIX.

Dimensions of *Edgewater:*

Length on water line	173 ft.
Beam on water line	34 ft.
Draft to base on trial	9 ft. 6 5-8 in.
Displacement to base on trial	687 tons.
Wetted surface to base on trial	5,764 sq. ft.
Propellers—diameter	8 ft.
" pitch, bow	10.03 ft.
" " stern	10.19 ft.
" projected area, each	26.4 sq. ft.

*Read at the November, 1902, meeting of the Society of Naval Architects and Marine Engineers.

Contract trials were run without cleaning bottom or any special preparation. A speed of 13.78 statute miles an hour was obtained as the mean of four runs with about 150 revolutions. The greater number of revolutions needed for that speed in these runs as compared with the progressive trials may have been due to any one or all of the following causes:

1. Slightly greater displacement.
2. Foul bottom.
3. Error in steering course; the buoys hereinafter mentioned were not used in the contract trials.

Before undertaking the progressive trials herein described the vessel was dry-docked and cleaned, but not painted, as the paint was quite new; and the next day the progressive trials with one screw astern were run. On the following day a similar set of trials was run with the vessel turned about, the screw being ahead and pulling the vessel instead of pushing it. After docking to replace the bow propeller, the trials with both screws in action were run.

The draft of the vessel was practically the same in all the trials. The course was 5,280 feet long in the Delaware river near Wilmington and directly off Deep Water Point. It had been surveyed several times by competent surveyors. The mean depth of water during the trials was in the neighborhood of 5 to 6 fathoms.

Each end of the course was marked by conspicuous range poles, and the longitudinal range was marked by buoys at the ends of the course. The routine of each of the three sets of progressive trials was identical with the same observers at the same posts; they had been previously drilled at the contract trials of the vessel.

The chief observer, stationed in the forward pilot house, started his stop-watch on entering the course, and at the same time pressed the button of an electric connection to the recording revolution counter in the engine room. He recorded each minute on the counter, and finally the moment of leaving the course, when he also stopped his watch. In this way the determination of the speed and revolutions, or, in other words, the slip and revolutions per minute, contained the personal error of only one man. The work of this observer was checked, as regards time on the course, by another observer in the pilot house and by the attendant at the recording counter in the engine room, who timed the click of the magnet; and as regards the total revolutions, by a man at the regular engine counter, who took readings by bell signals given by a third observer in the wheel house. The recording counter was simply a paper drum, belted to the propeller shaft and provided with suitable gearing, and a punch actuated by a magnet. It was calibrated from the engine counter immediately after each day's trials. It was found to have the same rate for any speed of the engine, the slip of the belt, if any existed, being constant.

The three stop-watches used were afterward carefully rated; one was sensibly correct, and the errors of the other two constant. The agreement between the two deck observers' timing, as corrected for the errors of the watches, is shown in the log sheets given elsewhere in this paper. There were three men at the indicators and a fourth to supply them with cards and give them signals. From four to seven sets of cards were taken on each run. The observer in general charge in the engine room saw to it that the speed of the engines was

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constant during each run, and as near the desired rate as was practicable. This duty would have been much less laborious if a tachometer had been attached to the engine where the engineer could easily see it.

The speed-revolution curves given on Plate I. were worked up by the method described in a paper on Tidal Corrections, which forms part of Vol. VII. of the Transactions of this Society.

The tide curves incidental to this method are given on the same plate. The slip curves follow directly from the pitch of screws and the speed-revolution curves. M.E.P.'s between cards from runs with and against the wind. The mean value with and against the wind for each speed was used in plotting M.E.P. curves; the spots from the average for each run were then plotted and found to agree.

The speed on Plate I. is in statute miles, this being convenient on account of the length of the course. On Plate II. the speed is in knots, the revolution curves and slip curves are taken directly from Plate I., and the power curves were drawn by calculation from the M.E.P. curves of Plate I. The spots in all cases leave

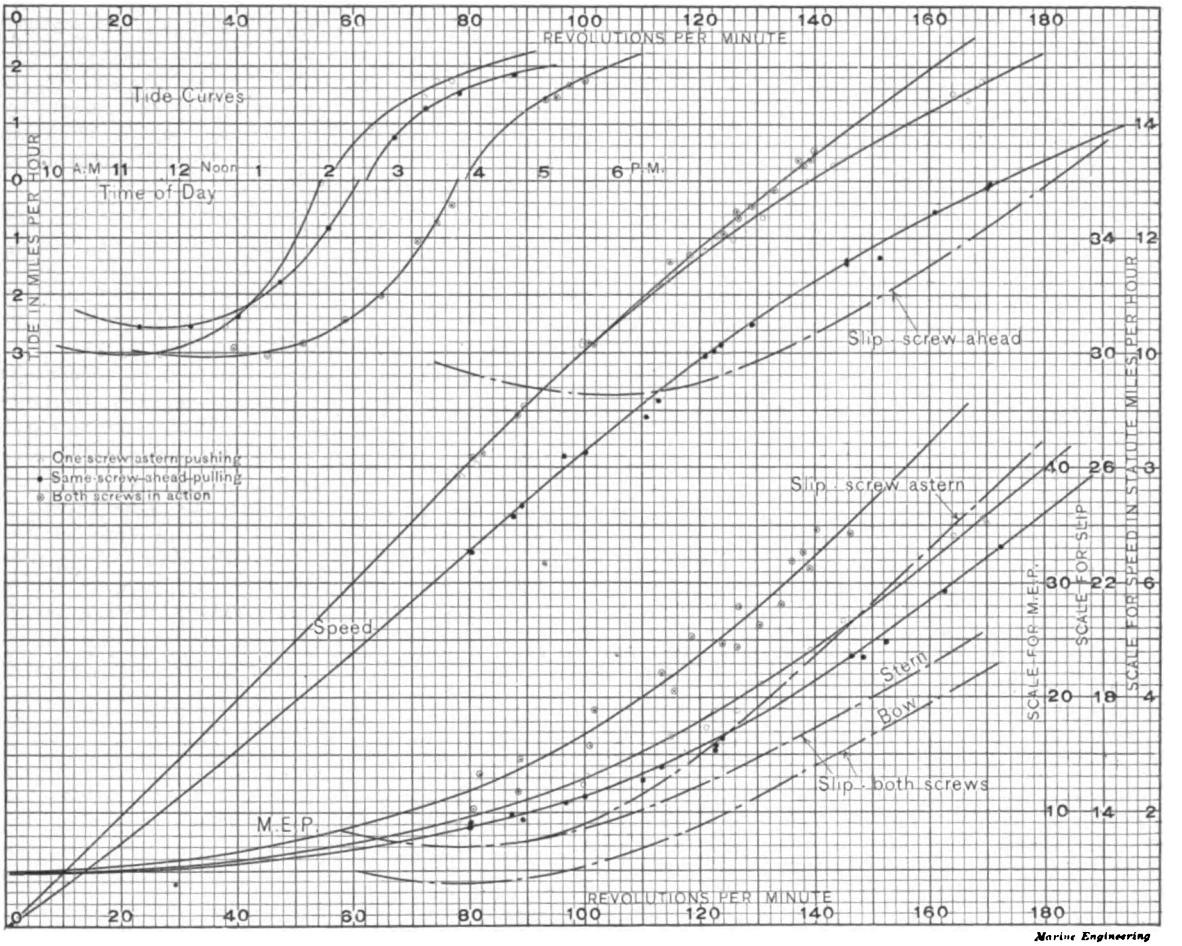

PLATE I.

The spots for the M.E.P. curves were obtained by averaging the cards taken each run, and plotting the average M.E.P. reduced to the low-pressure cylinders on the average revolutions for the cards. This latter figure was obtained from the recording revolution counter, a pencil mark having been made on the counter card at the moment of taking each set of indicator cards.

The punch marks made each minute on the counter card served to determine very closely the rate of turning at the time any indicator card was taken. This work was checked very satisfactorily by grouping all the cards at the same speed.

Decided differences were found at each speed in the little chance for variation in the drawing of the faired curves.

The irregularity of the M.E.P. spots for the trials with both screws is only apparent. The high spots are for the runs against the strong wind, and the low for those with it. The M.E.P. spots were plotted on both sides of the zero revolution ordinate, and battens laid through the spots.

In this way these curves were continued down to zero revolutions. The initial friction thus determined is extremely high. Indicator cards would have been taken at lower revolutions if time had permitted. While this friction may be lower than shown on Plate I., that very considerable initial friction existed is evident from the

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form of the Admiralty coefficient curve at the lower speeds. This was also shown by the fact that trouble was experienced from heating.

Annual Report of the Commissioner of Navigation.

The annual report of the Commissioner of Navigation shows that on June 30, 1902, the documented tonnage of the United States was the largest in our history, comprising 24,273 vessels of 5,797,902 gross tons. The increase over last year is almost wholly in large steel steamers, built by few shipbuilding plants for few shipowners. In ten years the number of American, British, and German square-rigged vessels has decreased 50 per cent. Tonnage registered for foreign trade shows a slight and unexpected decrease of 6,574 tons, which is more than offset by its increased efficiency as steamers supersede sail vessels. American vessels carried 8.8 per cent. of our exports and imports, compared with 8.2 per cent. in 1901.

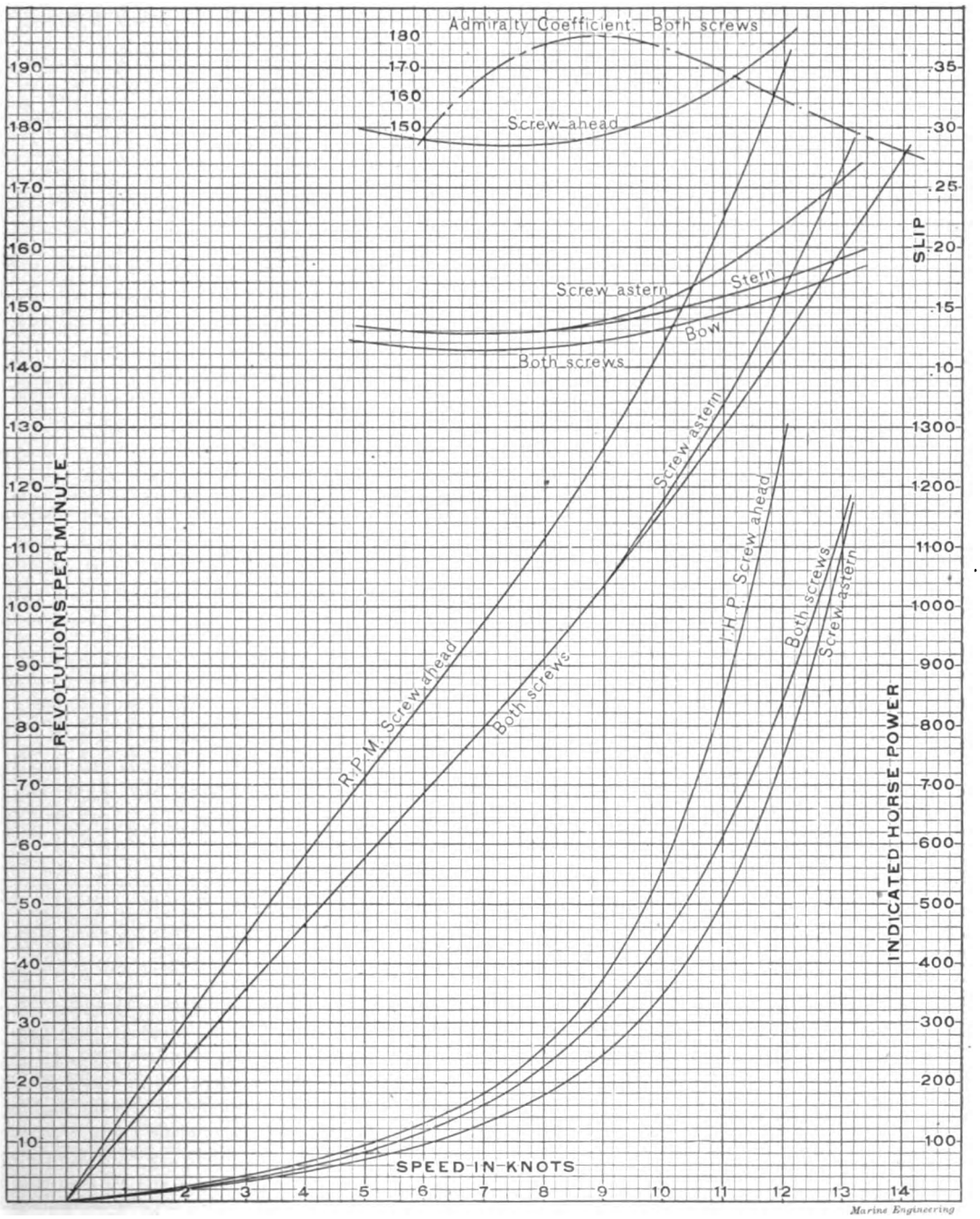

PLATE II.

The outlook for steel shipbuilding in the United States for the current fiscal year is not so promising as was last year's, but the same is true of Great Britain, where 1,000,000 tons of steel vessels were building on Sep-

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tember 30, 1902, compared with 1,400,000 tons on September 30, 1901. On July 1, 1902, there were building or under contract in the United States 347,500 tons of steel merchant vessels. A large percentage of the total has been finished in the first quarter of the year, and no new large contracts on the seaboard are reported.

The report contains a review of the crews (excluding masters) required to man the seagoing vessels of the

1		2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
No. of Run and Direction.		Approximate time of start.	Time on the mile. A M. S.	B M. S.	Mean time of A and B in minutes.	Total revolutions by recording counter.	Revolutions per min. from columns 4 and 5.	Total revolutions from engine counter.	Steam at start.	Steam at finish.	Vacuum at start.	Vacuum at finish.	Mean time of day for pair of runs.	Mean tide for pair.	Mean time of day for each run.	Mean tide for each run.	Apparent speed in statute miles.	True speed in statute miles.	M. E. P. high press.	M. E. P. low press. "A."	M. E. P. low press. "B."	M. E. P. referred to low.	R. P. M. for cards.	I. H. P.
1	D	11·05	8·02⅞	8·02	8.04	983	122.2	996	137	135	24	24	11-15	2.56	11-09	2.55	7.46	10.01	30.17	7.64	7.42	15.57	122.8	324.0
2	U	21	4-43½	4-43	4.72	584	123.7	588	133	135	24	.24			23	2.57	12.71	10.14	31.56	8.12	8.00	16.47	124.0	346.2
3	D	44	9-28⅞	9-29⅞	9.49		110.7	1050	134	134	23.2	23.2	11-58	2.57	50	2 56	6.32	8.88	24.95	6.32	5.98	12.80	110.2	239.1
4	U	12-06	5-09	5-08⅞	5.15	581	112.8	584	134	135	23	22.7			12-09	2.51	11.65	9.14	27.07	7 02	6.55	14 00	113.5	269 6
5	D	25	10-10⅞	10-11	10.18	1019	100.1	1025	136	133	22.3	22	12-39	2.39	30	2.37	5.89	8.26	22.82	5.50	5.22	11.44	100.0	194.0
6	U	48	5-46⅞	5-47	5.78	558	96.5	562	137	135	22.6	22			51	2.18	10.38	8.20	21.25	5.10	5.05	10.74	96.7	176.0
7	D	1-03	11-28⅞	11-28⅞	11.47	1066	87.7	1011	135	135	22.7	23	1-17	1.78	1 09	1.92	5.23	7.15	19.54	4 78	4.58	9.88	87 2	146.0
8	U	25	6-44⅞	6-44⅞	6.74	600	89.0	605	136	137	22.4	22.3			28	1.57	8.90	7.33	18 39	4.47	4 32	9.30	89.2	140.6
9	D	44	10-56⅞	10-57⅞	10.95	881	80.5	889	136	136	22.3	22	1-59	.83	49	1 06	5.48	6.54	17.71	4.50	4.23	9.09	80.2	123 5
10	U	2-05	8-26⅞	8-26⅞	8.44	676	80.1	681	134	135	21.7	21.7			2-09	.54	7.11	6.57	17.55	4.12	3.96	8.72	80.0	118.2
11	D	45	5-43⅞	5-43⅞	5.72	691	120.9	695	133	135	23	22.8	2-55	.75	48	.56	10.49	9 93	28.41	7.77	7.65	15.28	122.6	317.9
12	U	57	6-14⅞	6-13⅞	6.22	802	129.0	807	127	127	24	23			3-00	.84	9.65	10 49	.....	.....	.....	.....	.	.....
13	D	3-12	4-43⅞	4-42⅞	4.72	686	145.4	687	130	126	24	24	3-22	1.26	14	1.11	12.71	11.60	44.07	11 95	11.68	23.56	146.5	585.0
14	U	27	.....	5-52	5.87	855	145.6	860	127	126	24	24			30	1.32	10 22	11.54	43.88	12.07	11.55	23.50	148.5	592.0
15	D	41	4-34⅞	4-34⅞	4.57	691	151.2	692	133	127	23.9	24	3-51	1.51	43	1.46	13.13	11.67	46.33	12.75	12.22	24 84	152.3	641.5
16	U	55	5-31⅞	5-32	5.53	890	160.9	896	132	121	23	23			58	1 60	10.85	12 45	53.71	15.35	14 70	29.33	163.0	811.0
17	D	4-20	4-06	4-06	4.10	696	169.8	699	125	115	19.5	22	4 38	1.84	4-22	1.76	14.64	12.88	.	17.86	18.14	.....	171.3	.....
18	U	50	5-27⅞	5-27⅞	5.46	930	170.4	935	125	95	22	24			53	1.96	10.98	12.94	62.33	17.58	16.90	33.16	172.5	970.0

EDGEWATER.

Progressive Trials. One screw ahead pulling. April 24, 1902.

Mean measured pitch of screw, 10.19 feet. Light wind, smooth water. Mean trial draft, 10 feet 1¾ inches. Corresponding displacement, 687 tons. Wetted surface, 5,764 square feet.

1		2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
No. of Run and Direction.		Approximate time of start.	Time on the mile. A M. S.	B M. S.	Mean time of A and B in minutes.	Total revolutions by recording counter.	Revolutions per min. from col's 4 and 5.	Total revolutions from engine counter.	Steam at start.	Steam at finish.	Vacuum at start.	Vacuum at finish.	Mean time of day for pair of runs.	Mean tide for pair.	Mean time of day for each run.	Mean tide for each run.	Apparent speed in statute miles.	True speed in statute miles.	M. E. P high press.	M. E. P. low press. "A."	M. E. P. low press. "B."	M. E. P. referred to low.	R. P. M. for cards.	I. H. P.
1	D	12-25	6-57	6-57	6.95	821	118.2	826	115	105	23.8	24.1	12-36	2.93	12-28	3.06	8.64	11.70	47.14	12.90	12.62	25.32	118.8	510.5
2	U	44	3-59	3-58⅝	3.58	493½	124	492	105	103	23.8	23.6			46	3.02	15.08	12.06	46.43	12.10	12.44	24.64	124.0	518.2
3	D	55	7-18⅞	7-20⅞	7.33	828	113	831	104	110	23.6	23.7	1-05	3.06	59	2.98	8.18	11.16	40.22	11.16	11.54	22.07	113.4	424.4
4	U	1-14	4-08⅞	4-09	4.14	475½	114.8	480	126	116	23.8	23.5			1-16	2.93	14.49	11.56	38.22	10.26	10.46	20.55	115.7	403.0
5	D	23	8-16⅞	8-17⅞	8.29	841½	101.5	845	120	132	24.0	22.8	1-35	2.86	27	2.87	7.24	10.11	35.25	9.44	9.64	18.93	101.8	327.0
6	U	43	4-39⅞	4-39⅞	4.66	469	100.6	472	135	137	23.3	22.0			46	2.75	12.88	10.13	30.38	7.70	7.75	15.82	101.0	271.0
7	D	59	9-17⅞	9-17⅞	9.29	833	89.7	838	132	134	24.8	25.0	2-12	2.45	2-04	2.57	6.46	9.03	26.21	7.66	7.64	14.63	88.8	220.5
8	U	2-20	5-30⅞	5-20⅞	5.34	472½	88.5	475	138	136	25.1	24.7			23	2.32	11.23	8.91	21.72	6.04	6.02	11.82	88.5	177.3
9	D	30	9-52⅞	9-54	9.88	811	82.1	816	137	136	23.0	24.8	2-43	2.01	35	2.17	6.07	8.24	24.24	6.94	6.86	13.36	81.8	185.4
10	U	50	6-03⅞	6-02⅞	6.05	486	80.4	490	133	138	23.5	23.3			53	1.80	9.92	8.12	19.75	5.22	4.90	10.32	80.5	140.8
11	D	3-01	5-25⅞	5-26⅞	5.44	688	126.4	694	132	125	24.2	25.0	3-14	1.06	3-04	1.42	11.03	12.45	49.98	14.54	14.70	27.94	127.0	602.0
12	U	23	4-21⅞	4-21⅞	4.36	579	132.7	582	132	127	24.6	24.3			25	.92	13.76	12.84	50.50	14.40	14.80	28.05	134.3	639.5
13	D	34	4-38⅞	4-38⅞	4.64	648	139.6	653	133	121	24.2	24.6	3-31	.75	36	.58	12.93	13.51	60.68	18.32	18.50	34.58	140.5	824.0
14	U	4-20	.....	.....	....	....	.....	...	...	...	....	....	3-45	.44	....	....	.....	.....	70.59	15.60	15.44	34.33	146.5	853.0
15	U	52	4 59⅞	4-59⅞	4.99	695	139.1	699	113	103	23.7	24.5	4-59	1.42	4-55	1.33	12.03	13.36	56.03	16.24	16.28	31.18	139.2	736.0
16	D	5-02	4 04⅞	4-04⅞	4.08	562	137.8	565	102	100	24.1	24.0	5-10	1.45	5-04	1.44	14.71	13.27	58.63	16.70	17.40	32.69	138.3	767.0
17	U	13	5 34⅞	5-34⅞	5.58	708	126.8	712	105	106	24.8	25.0	5-22	1.67	16	1.60	10.75	12.35	46.35	12.00	12.18	24.44	126.8	526.0
18	D	27	3 58⅞	3-59	3.98	545	137	554	112	102	24.3	24.0	5-35	1.78	29	1.73	15.68	13.35	58.10	16.26	16.60	31.92	136.3	738.0
19	U	38	5 35	5-35	5.58	720	129	725			24.2	24.3			42	1.82	10.75	12.57	49.19	13.12	13.52	26.43	130.5	584.5

EDGEWATER.

Progressive Trials. Both Screws. April 26, 1902.

Mean measured pitch, of bow screw, 10.03 feet; stern screw, 10.19 feet. Vessel docked after trial of April 24 and screw replaced at engine end. Stiff wind, lumpy water; wind decreased somewhat during trials.
Trial with engine end ahead. Mean trial draft, 10 feet 1⅝ inches.
Corresponding displacement, 687 tons. Wetted surface, 5,764 square feet.

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United States of over 100 tons, foreign and coasting trades combined. In round numbers American seagoing steamers require 24,000 men, American square-rigged vessels 6,000 men, and American schooners 10,000 men. Crew lists indicate that 21,000 are Americans born or naturalized, and 19,000 are foreigners.

Last year 2,122 ocean steamers of 7,300,000 gross tons, including several hundred small tramp steamers, entered American ports in foreign trade. The export, import, and passenger business of the United States would require the continuous employment of 1,350 steamers of 4,900,000 tons, or over 20 per cent. of the world's foreign-going steamers. We employ, however, 40 per cent. of the large and fast steamships of the world. Speed is less useful to commerce than great size in steamers, but American trade exacts both.

The report prints at length the agreement of the transatlantic merger and its fleet of over 1,000,000 tons. The organization of so great a navigation company under American auspices is, however, the most important step toward the establishment of the influence of Americans on the ocean which has been taken since, through the rebuilding of the navy, modern shipbuilding plants were developed in the United States. The relations of the merger to the trade of the United States will be exceptional, the only parallel being the relations of the two great German lines to Germany's commerce.

Since 1894 steamers in the foreign trade of the United States under foreign flags, but owned by a large—probably a majority—interest of American capital, have increased from 200,000 tons to over 1,000,000 tons. In the same interval steamers under American register, including those in Hawaiian trade, have increased from 224,000 tons to only 398,000 tons. The policy of subsidies is the only method at the present time by which American-built steamers with American crews can obtain any considerable share of foreign trade. The repeal of compulsory pilotage on sail vessels in the coasting trade and minor changes in the navigation laws are recommended.

The report reviews the world's ocean steamship commerce for 1901 on the basis of reports of steamship companies owning about 40 per cent. of the tonnage in the world's foreign and colonial trade. These reports indicate that the world's foreign-going steamers in 1901 were valued at about one billion dollars, and that gross receipts were about $850,000,000, out of which $50,000,000 in dividends and $9,000,000 interest on bonds were paid.

1	2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
No. of Run and Direction.	Approximate time of start.	Time on the mile. A M. S.	Time on the mile. B M. S.	Mean time of A and B in minutes.	Total revolutions by recording counter.	Revolutions per min. from columns 4 and 5.	Total revolutions from engine counter.	Steam at start.	Steam at finish.	Vacuum at start.	Vacuum at finish.	Mean time of day for pair of runs.	Mean tide for pair.	Mean time of day for each run.	Mean tide for each run.	Apparent speed in statute miles.	True speed in statute miles.	M. E. P. high press.	M. E. P. low press. "A."	M. E. P. low press. "B."	M. E. P. referred to low.	R. P. M. for cards.	I. H. P.
1 D	10-29	lost.	7-16	7.27	833	114.6	836	140	133	22.5	23.5	10-43	3.00	10-33	3.02	8.25	11 27	33.61	7.58	7.56	16.53	115.1	322.4
2 U	53	4-02¼	4-02¾	4.04	487½	120.7	491	133	133	22.2	22	11-01	3.06	55	3.07	14.85	11.78	35.02	8.12	....	17 45	121.2	358.5
3 D	11 03	6-42¾	6-42¾	6.71	823	122 7	829	132	131	22 5	23			11-06	3 06	8.94	12 00	36.91	8.94	9.00	18.80	122.5	390.7
4 U	20	4-32¾	4-32¾	4.54	453	99.8	459	135	137	20.5	20.2	11-34	3.04	22	3.03	13.21	10.18	25.81	5.58	5.50	12.42	99.7	209.9
5 D	40	8-24¾	8-24¾	8.41	838	99.7	834	134	132	22.2	21.7			44	2.97	7.14	10.11	25 97	6.26	6.34	13.22	100.2	224.5
6 U	12-10	lost.	5-38½	5.64	443	78 6	504	137	135	23	23	12-29	2.56	12-13	2 77	10.64	7.87	18.65	4.24	3.96	9.07	78 0	120.0
7 D	38	10-25	10-25½	10.42	843	80.9	843	135	135	22.2	22			43	2.31	5 76	8.07	20.31	5.16	4.90	10 45	80.7	143 0
8 U	1-33	3-57¾	3-57¾	3.96	659	166.5	657	132	115	23.7	24.7	1-51	.06	1-35	.73	15.15	14.42	64 69	19.10	19.16	35.20	170.0	1015.0
9 D	2-05	4-02	4-02¾	4.05	664	164	663	122	100	19.5	19			2 07	.30	14.82	14 52	61.86	17 40	17.76	34.07	164.3	949.0
10 U	....	.....	.....	.....	....	.....	...	...	...	....	....	12-34	.92	.....	....	.....	.....	.....	.....	.....	.....	.....	.....
11 U	2-58	4-28¾	4-28¾	4.48	757	169	757	130	112	24	23.5			3-00	1 33	13 40	14.73	65.56	18.20	18.00	35.56	169.3	1020.0
12 D	3-12	4-05¾	4-05¾	4.09	....	143	585	127	127	24 2	25.2			14	1.43	14.67	13 24	51.39	12.84	13 00	26.61	145.0	654.5
13 U	23	5-16¾	5-16¾	5.27	731	138.6	741	138	135	24	25.5	3-20	1.44	26	1 60	11.38	12.98	46.95	11.60	11.57	24.10	139.3	570.0
14 D	35	4-16¾	4-16	4.27	558	130.7	561	135	140	44.2	25	3-31	1.71	37	1.70	14.05	12.35	40.26	10.37	10.47	21.15	130.7	468.5
15 U	48	5-54¾	5-54	5.91	742½	125.7	741	135	137	24.2	24	3-44	1.71	51	1.81	10.15	11.96	35.91	9.40	9.37	18.97	126.8	408.1

Explanation of Table.

Watch "A" given as read, watch "B" corrected as rated by chronometer.

Col. 12 is the mean time of day between start of one run and finish of next.

Col. 13 is found as follows: Tide in miles per hour $= \frac{\text{length of course in feet}}{88} \times \frac{\text{Revs. against—Revs. with}}{(\text{Revs. against} \times \text{time with}) + (\text{Revs. with} \times \text{time against})}$

Tide in Col. 15 is taken from tide curve drawn from figures in Col. 13.

Col. 16$= \frac{60}{\text{Col. 4}}$. Col. 17=Col. 16 $\pm$ Col. 15. Col. 21=.2665×Col. 18+ $\frac{\text{Col. 19+col. 20}}{2}$. Col. 23=Col. 21×.1696×Col. 22.

Col. 22=average R.P.M. for indicator cards obtained from the recording counter.

Engine $\frac{22 \times 30 \times 30}{24}$. Piston rods 4¼ in. dia.

EDGEWATER

Progressive trials. One screw astern pushing. April 23, 1902.

Mean measured pitch of screw, 10.19 feet. Vessel docked on April 22 and cleaned. Engine end screw removed. Light wind. Smooth water. Length of course, one statute mile. Mean trial draft, 10 feet 1⅝ inches. Corresponding displacement, 687 tons. Wetted surface, 5,764 square feet.

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THE relation between supply and demand in the field of engineering construction is still in the unsatisfactory condition which we have had previous occasion to note in these columns. The situation is in fact one which merits the careful study not only of all who may be directly concerned in these industrial activities, but of students of economic and industrial problems in general. The iron and steel industries collectively, and all manufacturing industries which depend upon them, are tied up with a situation in which the supply bears a totally inadequate relation to the demand, and the consequence is a most unsatisfactory condition as regards all engineering contracts, especially in relation to questions of price, date of delivery, time penalties, forfeitures, etc. This is true not only in regard to structural steel but pig iron as well, and it will not be exaggeration to say that all such contracts entered into during the past twelve months have suffered more or less severely from lack of material, and in only too many cases have exceeded contract time and have become involved in serious questions of penalties and forfeitures.

A contract is let to build a ship; the builder agrees to deliver at a certain date, with penalty for failure to do so. Material is ordered and promised in adequate time. The delivery is anywhere from one to six months or more behind the promise. The builder is penalized accordingly. Can he protect himself by a like penalty for non-delivery of material? By no means. The steel mills do not have to take orders with penalty clauses. The builder has therefore no manner of protecting himself and so must suffer. If he inquires into the situation he learns that the steel producers have booked their entire output for a year more or less, at a rate of output greater than they can reasonably hope to maintain, and that they are behind on all deliveries. He learns that questions of coal and freight cars also enter in, and that his material may actually be ready but must lie in the stock pile waiting for cars in which to be shipped.

It is much the same with other branches of engineering work. Thus, builders of heavy machinery make no pretence of carrying out their agreements. Investigation will show that the reasons are twofold: that they have booked far more work than they can handle, and that they are experiencing the same general trouble in getting material as noted above. Thus the tool builder pushes the blame back to the foundry where he obtains his iron and steel castings. They in turn push it back to the furnaces which furnish pig and coke, they in turn to the iron mines and coal fields. Thus the blame is shifted from one place to another, while in reality it should be pretty evenly distributed over the entire field.

It is easy of course to say that this is all wrong, but far more difficult to propose any adequate remedy. It would indeed be a skillful physician who could suitably prescribe for the present situation. We shall only note this one point: The present situation would never have arisen if everybody had during the past year observed in their promises strict business honesty, using the term not so much in its more common sense as in opposition to the temptation to promise more than can be performed. If firms learn that they cannot obtain material in less than six months' time, but that they can have it in three months and as much more three months later, the general demand is doubled, quite irrespective of the capacity for supply. With promises in accordance with the capacity for supply the demands would become adjusted all along the line, and a normal condition would prevail. Instead of this we have

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had during the past year or more the normal demands of six months crowded into three, those of three months into six weeks, and the present local paralysis in many establishments is the result.

The hope of an improvement in the conditions from a wider prevalence of the kind of honesty referred to above is perhaps utopian, but it is worth something to be able to see at least one of the chief causes of our trouble and to note a means of improvement, even if the likelihood of its adoption may seem to be remote.

The fact is that we are suffering from a phase of industrial prosperity to which we are not quite adjusted. There has been a demand for the products of industrial work far exceeding the available supply both of skilled labor and material, and the consequences we are now reaping. Would not a somewhat stronger infusion of business honesty and candor into the field of industrial operations aid in improving the situation?

WE have begun to write 1903 instead of 1902 and thus call it a new year. In one sense each day is just as truly the beginning of a new twelvemonth, if only we will so consider it. The custom of definite points to mark the change of times and season is, however, founded in wisdom and at such periods it becomes natural to note the progress during the past and the promise for the future. So far as the past year is concerned, there is perhaps no very startling achievement in marine construction to which we may point as of epoch-making importance. There has been progress all along the line, but for the most part in well-known channels and of such a character as only shows in the aggregate and after a long period of accumulation. It would, however, not be far wrong to say that the subject which has received the most attention, as involving elements of change and progress, is that of the application of oil fuel in marine service.

References to this topic and descriptions of working systems have appeared in our columns throughout the year, and especially in the December number. A study of these articles for the year would show impressively how much has been done and how live the interest in this topic is. Regarding the steam boiler as a means for generating steam, it is perhaps too much to claim that any notable advance has been made in this direction. The water-tube boiler is still to the fore and retains its hold on the naval services of the world, but it can be hardly claimed that it has made any special advance in the mercantile field.

The steam engine as a means of developing power is still our reliance and seems likely to remain so for some time to come, though in small craft the gas engine in various types has won an assured place, and one which is likely to grow in extent and importance, while the steam turbine has certainly entered the field to remain and presents claims which cannot be ignored. The propeller still remains our instrument of propulsion and it does not seem likely that it will be superseded, nor does it seem possible that any very notable improvement in it can be made.

So far as the year 1903 is concerned, it seems not unsafe to predict a growing interest in the use of oil fuel and a corresponding extension in its use. The water-tube boiler will perhaps make some small advances in the mercantile field, but the fire-tube boiler of the Scotch type will still remain the chief reliance. Increased attention is likely to be given to the mechanical perfection of the steam engine in the way of balance of inertia forces, etc., while the gas engine is likely to appear in increasing sizes and with a growing hold on the field which it has already so largely made its own. There seems no reason why 1903 should not witness the same gradual advance along the entire front as in 1902. On the other hand, it is hard to see from what direction to expect any startling or epoch-making improvements. Such, however, do not always herald their approach, and the advancing days can alone determine whether the coming year is to be thus signalized in the history of the art of marine construction.

AMONG the papers presented at the last meeting of the Society of Naval Architects and Marine Engineers was one on the progressive trials of the screw ferryboat *Edgewater*, a reprint of which will be found elsewhere in this issue. We wish especially to commend here the spirit which prompts the undertaking of such tests, and still more, when once taken, the giving of the data freely for the benefit of the profession at large. Only too seldom are those who are in control of such matters willing to devote the time and money required for a comprehensive test, and still more rarely are they willing to give out the result for the benefit of others. If, however, it is safe to assume that individuals profit most as the entire aggregate moves forward, each sharing in the progress of all, then such contributions to the progress of the body of marine construction as a whole are both generous and wise. It is earnestly hoped that more reports of a similar character will follow.

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PRACTICAL POINTS IN SHIPBUILDING.—III.

BY EADS JOHNSON.

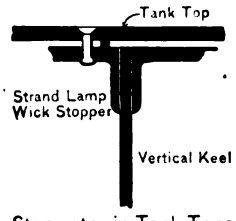
Stopwaters.

The term stopwater, as applied in a shipyard, is taken to mean any device whereby iron-work is made water-tight by any method other than iron calking. It often happens that parts of a ship are entirely inaccessible to the calker and his hammer, and then other means must be taken to make the parts water-tight. To accomplish this result, experience and ingenuity have done much in evolving the present forms of stopwater, and what follows is in a great measure the best results of long experience in this work.

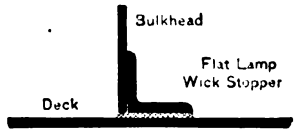
In water-tight work, when it is impossible to calk iron to iron, some filling substance must be placed between the two surfaces in order that they may be made water-tight. The best materials for this work have been found to be tar felt, flat-woven lampwick, strand lampwick, tar paper, white and red lead putty. It is necessary to treat the felt and lampwick some time before using them. For obtaining the best results from tar felt, smear it carefully with white or red lead paint of about the consistency of molasses. This will preserve the surface of the iron, and will have a tendency, when riveted up and set, of filling up any irregularities in the iron-work, and thus make a solid and secure job. Strand lampwick should be dipped in white or red lead paint of about the same consistency as above stated, before stretching in place, and when this sets it will form a perfect barrier to any water which might otherwise filter between the surfaces. Flat-woven lampwick should be thoroughly soaked in linseed oil for about twenty-four hours before being used; or, better, it can be kept indefinitely in a can or receptacle provided for this purpose alone, and then taken in quantities as wanted. When about to put the lampwick in place, smear it thoroughly with red-lead putty on both sides. The oil will keep the wick soft and pliable for an indefinite period, and, as it often happens that work will stand for some time before being riveted, this very quality of pliability is most essential. If the wick has been smeared with red-lead putty without having been soaked in oil, it very rapidly becomes as hard as wood, so that when the work is to be riveted the packing has such a resistance that it is impossible for the rivets to draw the two surfaces of the work tightly together. In consequence, there are numberless small avenues presented for water to find its way through the work, making this condition even worse than if no stopwater had been used.

Tar paper has been used successfully on light decks and bulkheads; it is very thin, and practically offers no resistance whatever when the two surfaces are riveted together. Red or white lead as a stopwater can be either spread thickly on the surfaces before the work is put together, or else forced in place after the work is riveted up, by means of an injector or putty gun, as it is commonly called. A glance at the drawing will show how much pressure may be applied to the lead by this simple device. The red lead from this machine has been known to travel as far as fifty feet along a protective deck, and in some cases, when used in the seams of shell plating, it has burst the rivets.

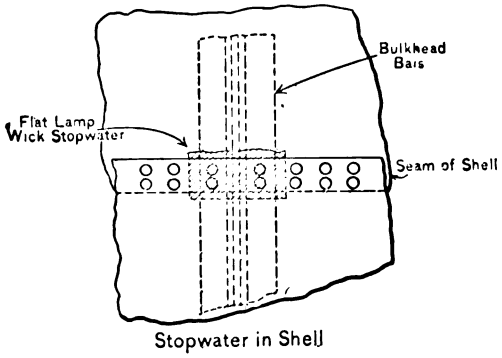
Tar felt should be used under staples, bitts, chocks, or any work requiring very wide materials. Flat-woven lampwick should be used under bulkhead bounding bars; margin lugs or inner bottom margin plates; the seams of the shell or deck plating where they cross a water-tight bulkhead, as this prevents the water entering the seams and traveling across the bulkhead; under angles of engine or boiler foundations on ships with inner bottom; or, in fact, any double bars where there is



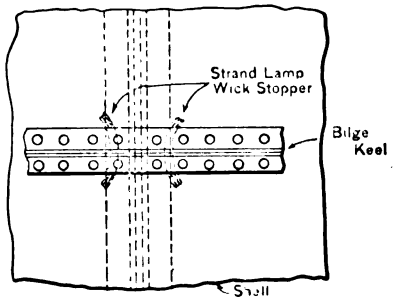
Stopwater in Tank Tops



Stopwater in Bulkhead



Stopwater in Shell



Stopwater in Bilge Keel

DIFFERENT FORMS AND APPLICATIONS OF STOPWATERS.

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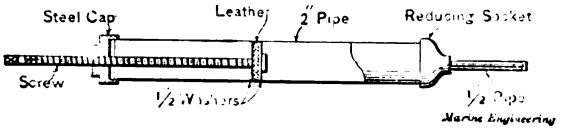
no possibility of calking the heels. The lampwick or tar felt can be securely bedded down first, and the holes corresponding to the plating punched through it with a red-hot bar sharpened at one end. Strand lamp-



RED LEAD INJECTOR OR PUTTY GUN.

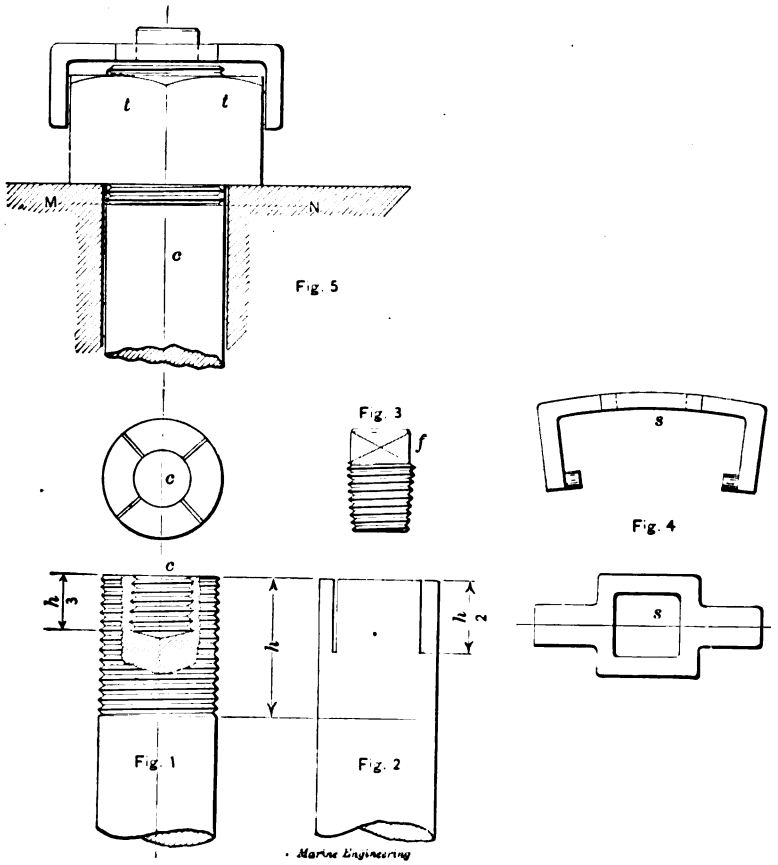
wick is of particular value when placed under the center tank top plate in inner-bottom ships on the calking side of the vertical keel, between the rivets and the heel of the bar. This prevents the water coming from the other side of the vertical keel into the calking side. It should also be placed in bilge keels and fenders where they cross a water-tight bulkhead, as the water can enter the heads of the rivets on one side, travel along the keel or fender, and come out on the other side of the bulkhead. For the same reason it is put under heavy protective deck plates where the plate covers a water-tight bulkhead.

Red or white lead is valuable in all places where the surfaces of the metals are so irregular as to form pockets or avenues for the water to find its way through. Red lead, when forced or pumped in by the injector, fills up all the spaces perfectly and makes a perfectly solid job. In conclusion, it might not be amiss to state that a stop-water should be used more in the character of making a virtue of a necessity. That is to say, it should never be used where calking can be done. There is more poor work done by the injudicious use of felt and lampwick than should be, which has caused much unwarranted prejudice in the minds of many who take but a superficial view of the matter.

New Locking Arrangement for Nuts.

BY N. AKIMOFF.

In most forms of lock nuts, locking is secured by the friction between the screw thread and the surface of the nut, and, in order to have this friction sufficient, the cap must be set up very tightly. Then the strains to be considered are not only the tension and shearing, but also the torsion of the bolt, which may be found by St. Venant's formula. If the strain acting along the bolt is P, it is necessary to design the bolt for strain P_1, which equals 1.65 P.



DETAILS OF NUT WITH LOCKING ARRANGEMENT.

Other considerations than the above make it necessary to use a very low working stress—say from 3,000 to 4,200 pounds per square inch for marine-engine connecting rod ends. Therefore, these bolts are always excessively heavy, and unreasonably increase the dimensions.

The purpose of this note is to call attention to an arrangement in which excessive tightening up of the nut becomes unnecessary, and the bolt will be subjected only to the strain P instead of P_1.

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In the accompanying sketch will be found details of the plan submitted. Drill and tap a hole, *c*, in the top of the bolt; the diameter of the hole will be, say, $\frac{d}{2}$, the depth about $\frac{h}{3}$; make four splits with a fine saw to the depth $\frac{h}{2}$, Fig. 2. If the thread of the bolt is right hand, the hole *c* is left-hand tapped. A steel screw, Fig. 3, is made somewhat beveled and tapped with the same thread as the drilled hole. When tightening up in the hole *c*, this screw will increase the friction in the top of the nut, and unscrewing will be absolutely impossible, as the pressure at the top of the thread may be easily made as tight as necessary. An additional locking device is found in the small spring *s*, Fig. 4, which is of somewhat peculiar shape. In each side of the nut is drilled a hole, *t*, about 1-4 inch deep.

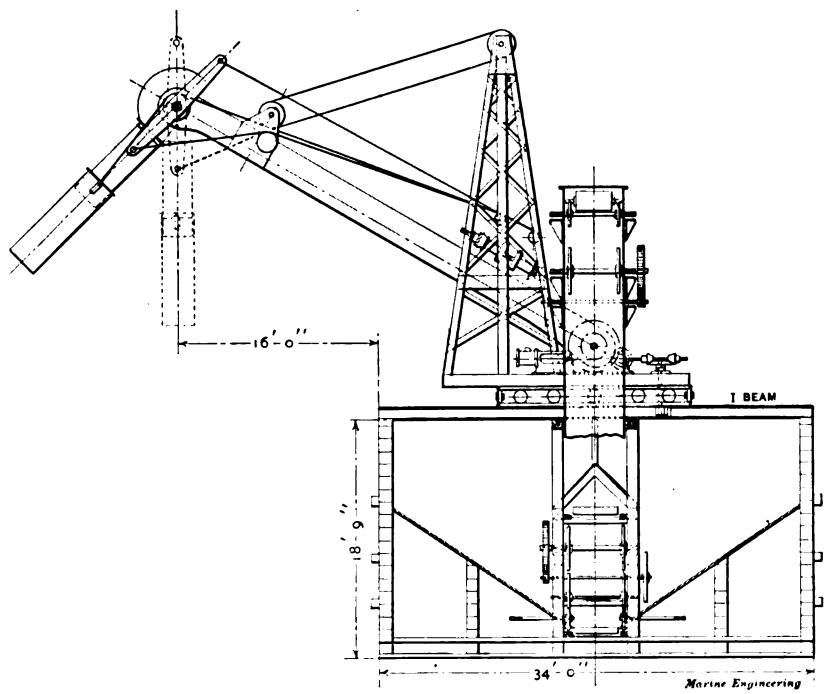
The setting up of these parts may be clearly understood in the general view of the lock shown in Fig. 5. It is evident that it is impossible either to unscrew the nut or the screw, as the threads of one are made opposite the other. It is unnecessary to screw the top very tight, and it is easy to find the proper position where the spring will fit in the drilled holes *t*. As for shearing of the threads, all the tensions remain exactly the same as in the nuts formerly used, and the dangerous section of tension is *MN*.

Steamer Siberia.—The second of the sister ships built for the Pacific Mail Steamship Company at Newport News, Va., the *Siberia*, recently sailed from New York via the Straits of Magellan for San Francisco, where she will be placed in the transpacific service.

Self-Propelled Fueling Steamer.

There has been recently built by C. O. Bartlett and Snow Company, of Cleveland, for the Pittsburg Coal Company of that city, the machinery for a self-propelled twin-screw fueling steamer, the general construction and operation of which is as follows:

The steamer is 165 feet long, 25 feet beam, 8 feet depth of hold, being large enough to carry 750 tons of coal aside from her machinery. The main body of the vessel is provided with hoppers which take up nearly the entire length, and are arranged in two rows, one on each side. Along the center line, at the bottom, is a tunnel which extends the length of the pockets and carries the conveyor. The conveyor consists of two strands of heavy chain, to which are fastened flights. Each hopper is provided with an outlet into the tunnel of about 3 feet square, and as the coal falls into the conveyor it is carried by the flights to the end of the vessel, up a short incline, and delivered to an elevator.



CROSS SECTIONAL ELEVATION OF FUELING STEAMER.

The main body of this elevator consists of sheet-iron plates, to which angles are fastened, forming the guides for the chain. There are also two strands of heavy chain, to which are fastened the buckets, centrally hung. These take the coal as it leaves the conveyor, elevate it, and deliver it into a centrally located hopper, mounted on a turntable. Immediately under this hopper is the lower end of an inclined elevator. This elevator is so arranged that the outer end can be raised or lowered so that it will deliver coal to the vessels to be fueled at any angle from the horizontal to 45 degrees. To this end is attached a telescope spout, so arranged that it may be swung out or in to accommodate itself to the hatch of the boat which is being loaded, and also raised and lowered as desired.

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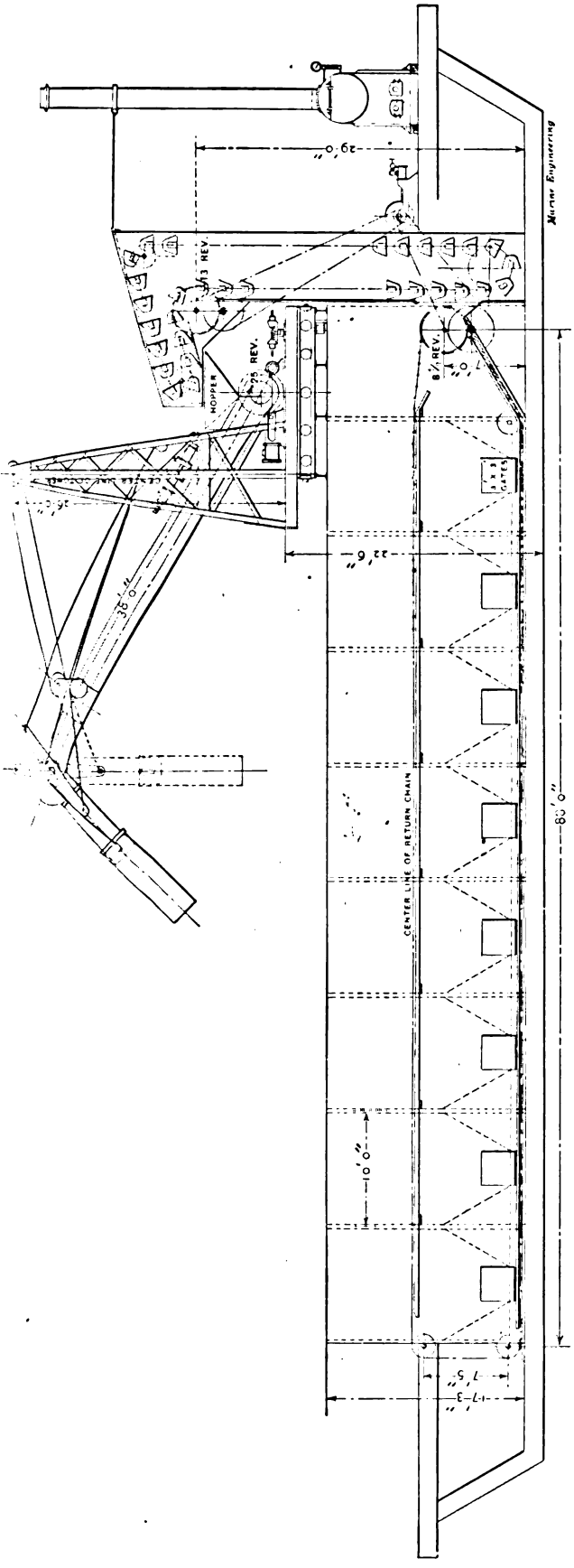

LONGITUDINAL SECTIONAL ELEVATION OF FUELING STEAMER.

The motive power for this inclined elevator is derived from a double-cylinder engine of sufficient capacity, located on top of the turntable. This engine also operates the telescope spout and furnishes power for revolving the turntable, by means of which the inclined elevator can be turned to fuel the boats on either side. There is also provided a double-cylinder engine, which is mounted on the deck of the steamer, for operating the conveyor and elevator. Both engines are supplied from a boiler of 150 horse power, placed on deck.

The propelling machinery consists of two 13 by 15 inch non-condensing engines driving 5-foot wheels.

A German View of American Technical Training.

Dr. Vosberg-Rekow, a German expert, has recently visited the United States and examined into the system of industrial educational progress. In an article recently published by him in a German paper, he comments upon the subject of education as follows:

"German industrial advancement is due principally to the thoroughness of our technical education. It is strengthened by the continual introduction of machinery and machine-made tools for hand labor. It is worthy of note that in this evolution, too, the United States has the foremost place and has made gigantic strides not only in applying machine tools, but in inventing and manufacturing them, so that to-day she supplies us.

"This signalizes in an extraordinary degree the keenness of American intelligence. Thus, Americans, though wanting our supplementary technical education, thanks to their practical eye, improve upon our methods and apparatus. Theirs is rather the activity of the experimentalist than that of the plain craftsman; but a clever faiseur, if he but have assurance and luck, may distance his educated master. The Americans have no thorough education, nor do they possess a modern industrial system as we Europeans understand those terms. The American applies himself to a single branch or specialty, with utter disregard of European methods and their results; he devotes to his work an amount of energy which simply stupefies Europe, and for a while he succeeds in driving us out of the line of articles on which he has centered his energies."

Washington Experimental Tank.—In his annual report, Admiral Bowles, Chief Constructor of the Navy, pays a high tribute to the utility of the experimental tank at Washington and cites cases to show that this tank has been of great value to the Department. Some torpedo-boat destroyers, built to the design of the Navy Department, did not attain the required speed, and the builders blamed the lines of the hull and estimated that the alterations necessary would cost about $35,000. Experiment, however, in the tank proved that in some cases the propellers were at fault, and in others that trivial alterations in the hull, costing only $2,500, would insure the required speed. As a result of model experiments, too, a cruiser of 14,500 tons displacement has been laid down which requires less horse power for a speed of 22 knots than a cruiser of another class running at the same speed but only displacing 13,680 tons; while the new 16,000-ton battleships will run at a speed of 18 knots with less power than similar vessels of 1,000 tons less displacement.

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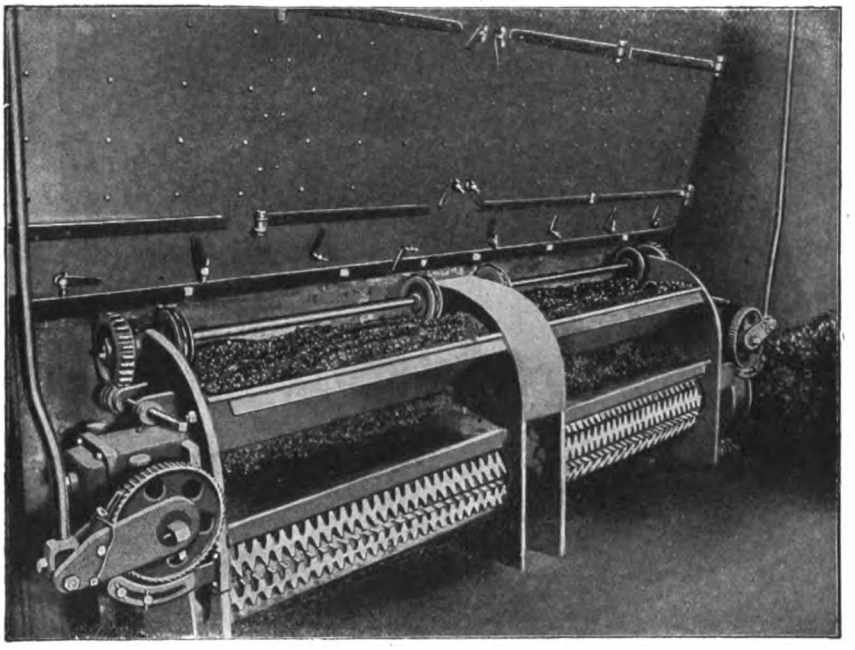
ENGINEERING SPECIALTIES.

The Duluth Stoker.

The stoker here illustrated and made by the Duluth Stoker Company, Duluth, Minn., consists of an endless belt of grate bars; the bars lie crosswise in the furnace, parallel to each other, and are carried by two endless chains, one on each side of the furnace. In front of the furnace the chains pass over sprockets, from which they receive their motion, and at the back of the stoker they pass over sheaves which are keyed to the shaft which is carried by dust-proof bearings at either end. To each of these bearings is attached an adjusting screw to give the proper tension upon the chains which carry the grate bars.

Both the top and bottom members of this chain of grate bars are supported by rollers or fairleaders. The motion of a top member is from the front of the furnace toward the back, and in the front and above the grate bars is placed a hopper for receiving the coal. The motion of the grate bars under the hopper carries in a film or layer of coal upon the bars, whose thickness is determined by a regulating plate which extends the whole width of the stoker and is adjustable for height, so that the thickness of the fire may be regulated to suit the demands for steam. At the back end of the stoker is placed a forged steel water box in the water circulation of the boiler, which serves the purpose of preventing the good fire from falling over the back end with the ashes and clinker. This end is adjustable for height, so that the space between grate bars and cross box can be regulated to suit the different size of clinker formed when various kinds of coal are being burned. Its action is as follows: The ashes and clinker pass underneath the cross box, following the motion of the grate bars, while the unconsumed carbon lying on top is held back by the lower edge of the box, effectually closing up this opening and keeping the back end of the furnace covered with good fire. The loss of coal down through the grate bars is prevented by placing underneath the bottom member a plate, which catches the fine coal sifting through the grate bars.

The grate bars each have two wrought-iron lugs or hooks on their lower edge, which hook into the links of the chains, alternate bars hooking in from opposite sides. The upper faces of the bars are toothed and lock into each other, leaving sufficient opening between them to admit the proper quantities of air to the fire. It is only possible to remove these grate bars while they are passing over the front sprockets. The sprockets on the front shaft of the stoker, which drive the chains, are operated by a single worm and worm wheel, the worm being driven by ratchet connected to eccentric rod, the eccentric being carried on the line shaft placed above the stoker.



THE DULUTH STOKER FITTED TO MARINE BOILER.

The marine boilers to which these stokers have usually been applied are of the Babcock and Wilcox water-tube type, placed athwartship with their fronts facing each other, and have two stokers installed under each boiler. Two line shafts, extending along the front of each set of boilers and run by separate engines, drive the stokers, as shown in the accompanying sketch. The engines are bracketed on the engine-room side of the bulkhead and so are under the care of the engineer. A cross drive is provided between the two line shafts, so that the whole stoker plant, in case of necessity, could be driven by one or the other engine.

These stokers are producing at all times smokeless combustion with a cheap grade of slack coal, and their economy is due, in part, to the fact that the heating surfaces are kept free from a soot deposit, rendering them capable of readily absorbing the intense heat generated by the stoker fire. The operation of stoking

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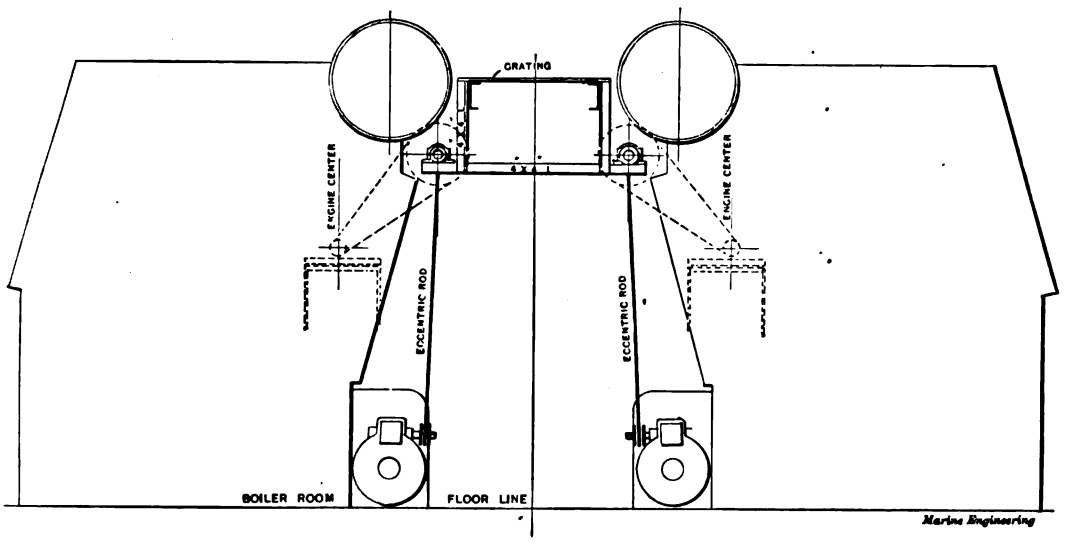
consists simply in supplying the hoppers with coal and removing the ashes from the rear of the boilers; and as fires require no poking, slicing, or other agitation, and as there are no fire doors to be opened, admitting cold air to the furnaces, it is evident that economy is sure to result from their use.

The body of the Duluth stoker is composed almost entirely of structural steel, and the very best material and workmanship are employed throughout its entire construction. The driving gear is enclosed in oil-tight and dust-proof casing, insuring easy working and freedom from destructive wear. The ratchet which drives the worm shaft is supplied with a regulating device, by which the stoker can be stopped instantly without stopping either the engine or line shaft, the same adjustment also permitting of five changes in speed, so that with adequate means to regulate the thickness of the fire upon the grates, and also the speed of the grate bars, it is possible to meet all requirements for steam.



ARRANGEMENT OF DRIVING SHAFTS FOR DULUTH STOKER, LOOKING FORWARD.

Direct-Connected Engines.

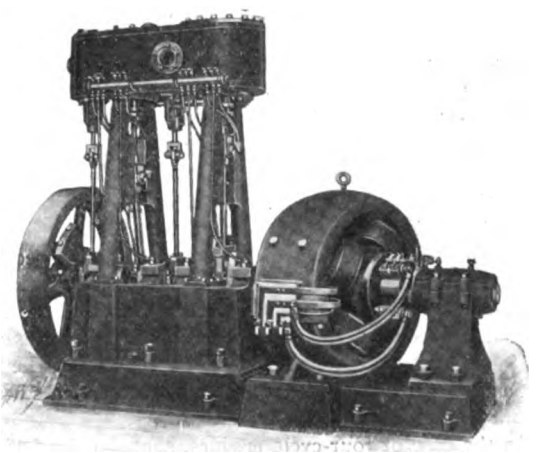
The John E. Thropp and Sons Company, builders of marine and stationary engines and boilers, of Trenton, N. J., has placed on the market a line of high-speed engines for direct connection to electric generators, one of which is herewith illustrated.

Engines of this class where the load varies and the speed is high require the best material and workmanship. The cylinders are supported upon hollow cast-iron housings which are securely bolted to a substantial bed. Each engine is fitted with oil guards, and the bed plates are so constructed that all the waste oil is caught and passes out at the bottom of the plate through a small pipe. The housings and bed plate are bored in the lathe after being babbitted, to guarantee the alignment. The main bearings are of the inserted type.

All the castings are made of best charcoal iron, hard, close, and free from sand holes. The high-pressure valve is of the balanced piston type and the low-pressure valve of the balanced slide type, which overcomes one of the serious objections often encountered in high-speed engines. The crossheads are made of steel, fitted with brass gibs. The crank shaft is made extra large and of forged steel, having large crank pins, which insure a smooth working engine. The connecting rods, eccentric rods, piston rods, and valve stems are also of forged steel, finished entire length.

The cylinders are jacketed with Russia iron and lined with asbestos, and banded top and bottom with either brass bands or strips of Russia iron.

Each engine is fitted with a Detroit sight-feed cylinder lubricator and a large multiple sight-feed oiler completely piped to all moving parts. The body of the oiler is of finished brass and makes an attractive addition to the engine. Each engine is fitted with one Rites inertia governor, guaranteed to regulate within 1 1-2 per cent. between full and no load.



DIRECT-CONNECTED GENERATING SET.

Every engine is fully guaranteed as regards material and construction.

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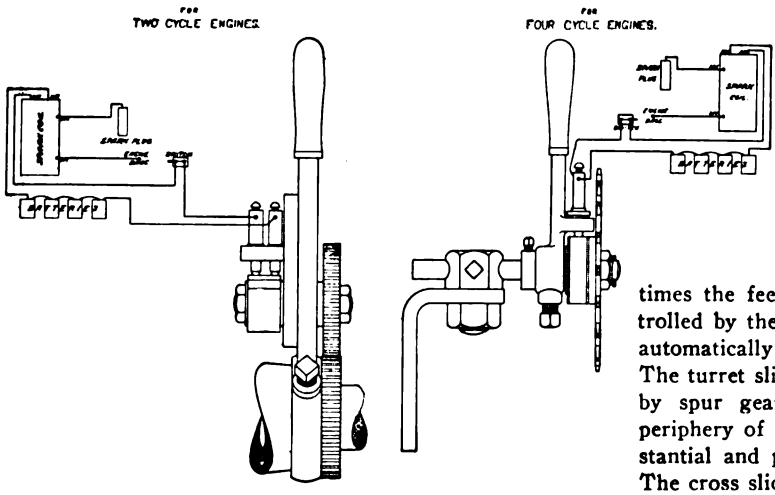
The Detroit Igniter.

This igniter may be put on any engine of one or more cylinders by the user of the engine.

The cause of most troubles with gas engines is the igniter. The tube igniter frequently requires new tubes. When one gets a little old, the engine will miss explosions and fire the expelled charge in the exhaust pipe. Considerable fuel is used to heat the tube and ten to fifteen minutes are required to start. It is also unsafe to have a flame in a closed room where there is apt to be gasoline exposed to the air.



IGNITER FOR TWO- AND FOUR-CYCLE GAS ENGINES.

The touch spark electric igniter has, of course, a moving electrode through the cylinder walls. The burnt gas and intense heat cause this igniter to stick, corrode, and give trouble, while the points become covered with deposits from the gas and finally refuse to make a spark, and in most engines it is necessary to break a packing joint to remove the electrode for cleaning. A wipe spark igniter is subject to frequent breakage and rapid wear, which soon interferes with the proper point of ignition, while with any ordinary igniter there is little or no provision for changing the point of ignition for starting the engine—a feature of great importance and much desired by all users of marine and stationary engines.

With this igniter to start the engine the commutator handle is readily shifted, and after the engine is started the lever is placed so as to secure any point of ignition desired.

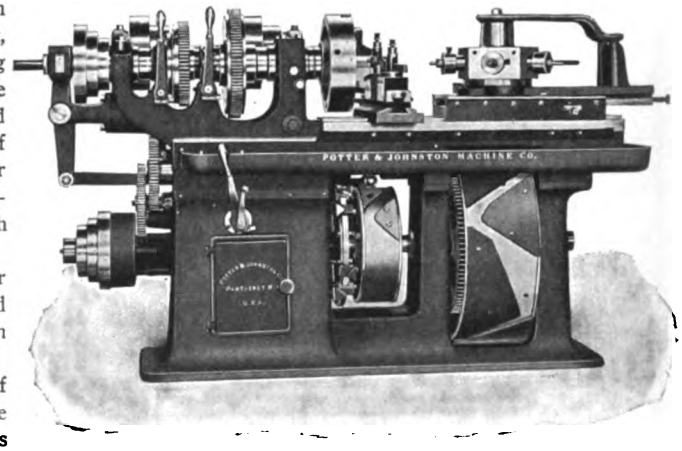
With this igniter no moving parts are on the inside of the cylinder, therefore there is nothing to become gummed up and stick. The sparking plug screws through the cylinder wall into the combustion space, so that it can be removed in a moment's time if necessary to inspect or clean. The spark jumps between the intervening points at the end of the plug, these points being about 1-32 inch apart.

In the case of four-cycle engines, should it be desired to make a spark only as often as the charge is drawn into cylinder, this device may be furnished in such form as to accomplish this purpose.

Further information may be obtained from the Detroit Motor Works, Detroit, Mich.

Automatic Chucking and Turning Machine.

The cut shown herewith represents the latest improved automatic chucking and turning machine, which has recently been placed upon the market by the Potter and Johnston Machine Company, Pawtucket, R. I. The machine is arranged for the automatic production of all kinds of castings up to 10 inches diameter and 6 inches long. It possesses several new and very valuable features heretofore unknown to this particular class of machinery. The turret has five sides, with 2 1-2 inch holes, and it withdraws, revolves, and advances at forty times the feeding speed. The feed is driven and controlled by the spindle. The cross slide can be operated automatically at any time in conjunction with the turret. The turret slide is operated by a large cam drum driven by spur gearing, the power being applied near the periphery of the drum. This arrangement is very substantial and prevents any spring of the working parts. The cross slide tool blocks have a travel of 4 1-2 inches in each direction, and have screw adjustment on cross slide. The standard set of cams furnished with the machine covers all ordinary pieces up to 6 inches long and requires no adjustment.



AUTOMATIC CHUCKING AND TURNING MACHINE.

The automatic back-facing attachment shown in cut is a very valuable addition to the machine. This attachment enables the hubs of gears, pulleys, etc., to be finished on both ends at one setting, and in this manner a large variety of pieces which would ordinarily require to be done in two holdings can be finished complete at one setting. Another very interesting feature in connection with the machine is the automatic chuck. By the use of this chuck pieces which can be handled with

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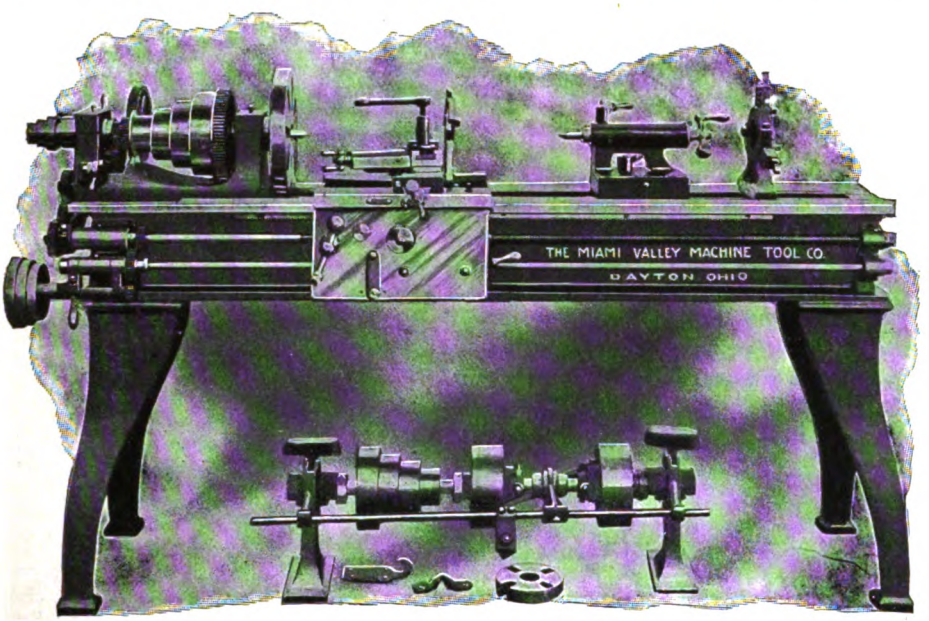
one hand can be placed into the same and removed without stopping the spindle; thus the machine is running all the time, and requires very little attention from the operator, hence he can readily run from four to eight machines, according to the class of work being done, making the labor cost of production a very small item in comparison with the increased product obtained.

For gripping extra heavy or eccentrically-shaped pieces, a heavy scroll chuck is furnished with the machine. A pair of universal turning and facing tools is furnished as part of the standard outfit of the machine, and takes care of all ordinary pieces up to 10 inches diameter. The machine is made in three types, viz.: with geared automatic change speed head, with belt-driven change speed head, with plain head. The machine has plenty of power, strength, and rigidity; all working parts are simple and easy of access.

Although this new designed tool has been on the market but a comparatively short time, it has been favorably received by the trade, and is used in a number of shops, including the following lines: Textile, woodworking, pumping, power transmitting, electrical and paper making machinery; printing presses, punches, presses, pneumatic tools and air brakes, etc.



A NEW LATHE.

New 13 1-2-Inch Lathe.

A new 13 1-2-inch lathe is shown in the illustration, made by the Miami Valley Machine Tool Company, Dayton, O. No novel features have been introduced in the design, the main considerations having been to produce a lathe with parts of ample proportions, convenient to operate, and durable and accurate in construction. The spindle is of high-grade steel, with ground journals and phosphor-bronze boxes. The cross feed is graduated. The chasing stop is always with the lathe, and it is impossible to throw in rod and screw feeds at the same time. The feed cone is provided with a swinging tightener. The centers are large, with no bushing in the spindle, but a safety plug is provided to avoid accident when the center is removed. The tailstock is of the overhanging style, with set-over. The feeds in head and apron are reversible. The head and tail stocks are fitted to the bed with a V at the rear and flat bearing in front, permitting the cross-bridge of carriage to be heavy and rigid. Besides the belt and rod feed, a positive feed can be obtained by engaging gear on lead screw to the feed rod. The carriage is provided with lock screw. It has V bearing in front and flat bearing in rear, and is gibbed. All sliding bearings on the V's are fitted to completely cover them and avoid wearing a ridge in them. The power cross feed is thrown in and out by moving a button. The countershaft has double friction pulleys, simple in construction and easy of adjustment. Care has been taken to insure perfect facilities for oiling all bearings, especially in the apron. The compound rest is graduated in degrees.

The feed belt has swing tightener, the test limit on the spindle is .001 inch.

The front bearing of the spindle is 2 inches diameter, 3 3-4 inches long; the rear bearing of spindle, 1 5-8 inches diameter and 3 inches long; and the hole through the spindle, 1 1-16 inch. The diameters of the head cone pulley are 3 1-2, 5, 6 1-2, and 8 inches, and the ratio of the back gearing is 9.1 to 1. The lathe cuts threads 4 to 64, including 11 1-2.

Travelers' Electric Stove.

The outfit illustrated on the next page meets a very pressing demand for an electric heater equally as useful at home as when traveling. The bottom is recessed, so that the cup encloses the heater when set upon it and locks in place. The heater is oxidized steel and the frame white enamel. It has 6 feet of conductor cord and a lamp socket plug with an adapter, so it may be connected to either Edison or "T. H." sockets. An as-

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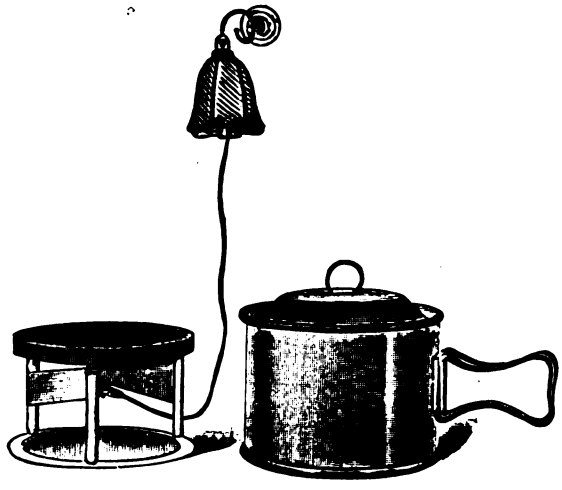
bestos table pad permits its use on a polished table without injury from heat.

The cup has a capacity of three half pints; is heavily tinned inside; polished nickel outside. All parts pack



ELECTRIC STOVE FOR TRAVELERS' USE.

within the cup, which is 3 1-4 by 5 inches, and weighs complete two and a half pounds packed. The manufacturer, the Simplex Electric Heating Company, Cambridgeport, Mass., has made and sold thousands of electric heaters the same size but of less portable form. The heaters are made from 110 to 250 volts current.

Wreck of the Steamer Delano.

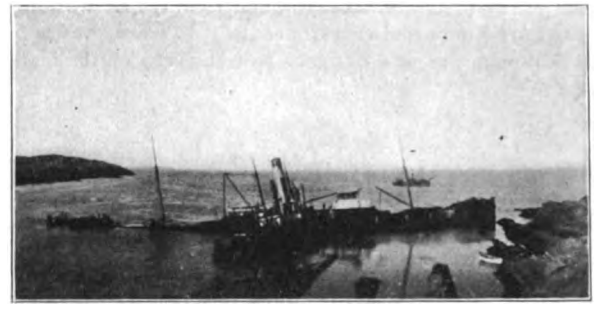
Editor MARINE ENGINEERING:

Another ship has been added to the long list of marine victims that have left their bones on the rock-bound shores of Newfoundland in the neighborhood of Cape Race. This time it is the steamer *Delano,* which was on a voyage from Rotterdam to Baltimore, via Sunderland, where she coaled.

The vessel struck at a place called Seal Rocks, near the fishery town of Reneives and about twenty miles north of Cape Race. She went on shore at 8 o'clock in the morning, during a fog so dense that the ship could not be seen her entire length. Fortunately, the weather was calm and the water comparatively smooth at the time, otherwise all on board might have been lost. As it was, the boats were got out without any difficulty, and the crew landed in safety. The captain and officers remained on board until next day, when Lloyds' agents arrived. After the latter examined the ship they found a number of holes in her bottom, and, deciding that she was beyond getting off, she was condemned and sold. All the provisions, clothing, furniture, and loose gear have been saved.

In accordance with marine regulations, the captain was examined by the board in connection with the loss of the ship. After the strictest and most minute inquiry, the board exonerated him from all blame, inasmuch as he had taken all human precaution in navigating the ship during the fog. His log shows that he should have been thirty miles from land when the vessel struck, and his position was entirely due to a strong northwardly tide, which threw all his calculations out, The steamer went ashore near where the *Scottish King* was lost two years ago.

Every steamer that approaches the neighborhood of Cape Race in foggy weather makes a certain allowance for tide, and generally this allowance brings the ship clear. But at certain periods, which no experience can define, an extraordinary tide sets in and defies the skill of the best navigator on the Atlantic. The present Minister of Marine in this country (Mr. Murphy) is deeply interested in the tidal vagaries of Cape Race and neighborhood, and he has recently had a map prepared, on which the location and name of every wreck for half a century is placed. M. A. D.



THE STEAMER DELANO ON SHORE.

Torpedo-Boat Destroyer Lawrence.

On the official standardization trial the torpedo-boat destroyer *Lawrence,* built at the works of the Fore River Ship and Engine Company, Quincy, Mass., made a record of 29.4 knots. The trial was held over a measured mile off Provincetown, in Massachusetts Bay, and was in charge of the Official Trial Board. Following is a summary of the results of the standardization trial:

Run.	Time.	Mean revolutions.	Rate of speed.
1 south	2.384	749.5	22.727
2 north	2.332	732.5	23.499
3 south	2.202	757.5	25.678
4 north	2.180	735.5	26.087
5 south	2.120	750.0	27.273
6 north	2.130	750.0	27.068
7 north	2.098	752.5	27.735
8 south	2.038	738.0	29.079

The auxiliary steam pipe in the after engine room burst just as the *Lawrence* was making her sixth run over the course, and prevented her from being turned in order to make the distance in the opposite direction, as she had previously done. The difficulty was soon remedied, but it had reduced her speed sufficiently to make a perceptible difference in the figures, but the record on the run was 29.4 by the official record.

The load-water-line length of the *Lawrence* is 240 feet 10 inches; length over all, 246 feet 3 inches; extreme breadth, 22 feet 3 inches; mean draft, 6 feet 3 inches; depth from deck to keel, 14 feet; displacement, 400 tons; and full-load displacement, 514 tons. Coal bunkers stand on either side for a length of 100 feet amidships and have a capacity of 147 tons, which, it is calcu-

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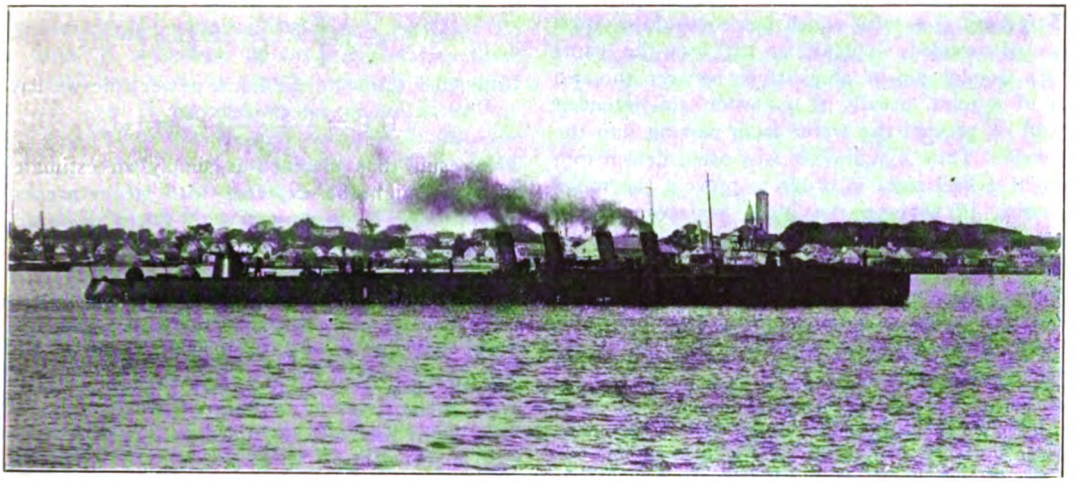
lated, will give the vessel a steaming radius of 3,000 miles at 14 knots or 1,000 at 30 knots.

The *Lawrence* has twin screws and vertical, inverted, direct-acting, four-cylinder, triple-expansion engines. The high-pressure cylinder is 22 inches, the intermediate 31 inches, and the two low-pressure cylinders 34 inches in diameter, and the stroke is 20 inches. The main engines are in two separate compartments amidships, the starboard engine being placed forward of the port engine, and at 360 revolutions, with steam at 240 pounds, they are designed to develop 8,400 horse power.



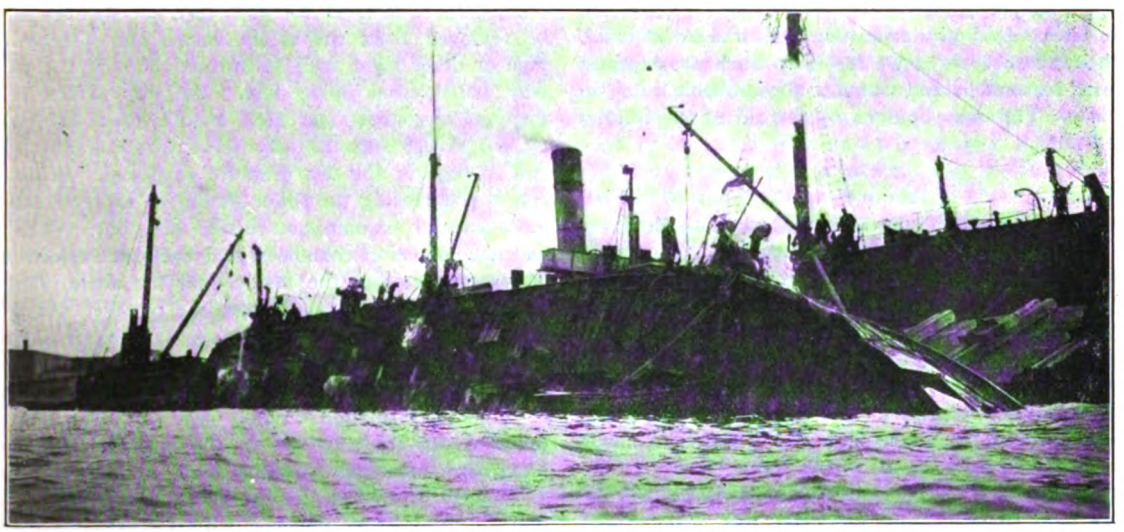
TORPEDO-BOAT DESTROYER LAWRENCE.

The water-tube boilers were made by the Fore River Company from its own designs, and they are placed, two in the forward and two in the after fire room, the fire rooms being forward of the engine rooms. The grate surface aggregates 315 square feet, and there are 17,768 square feet of heating surface, with two blowing engines for forced draft in each fire room.

The destroyer is designed to carry two torpedo tubes for long 18-inch Whitehead torpedoes, mounted on the fore-and-aft line of the main deck. She will also carry two 3-inch rapid-fire and five 6-pounder rapid-fire rifles. The torpedo tubes are to be carried in water-tight compartments just below the main deck.

Tank Steamer Maverick.

The possible dangers in the transportation of oil in bulk are illustrated in the accompanying view which was taken of the Imperial Oil Company's tank steamer *Maverick*. The *Maverick* was discharging a cargo of oil in Halifax, N. S., when the discharge pipe sprung aleak and allowed the oil to flow down into the hold of the steamer unnoticed until it reached the furnace door in the boiler room. The oil then ignited, and in order to save the ship she was towed down to Bedford Basin and there beached and scuttled. The following spring the vessel was raised after two unsuccessful attempts; and the photograph was taken when she was finally floated. The ship was then taken to a New England port for repairs and is now running in her usual capacity.



OIL-TANK STEAMER MAVERICK, BEACHED NEAR HALIFAX.

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QUERIES AND ANSWERS.

Q. 114.—Will you kindly answer, in your valuable inquiry column, the following question: What is a stopwater, what is it used for, what are the different kinds of stopwaters?

M.

A.—Stopwater is a term which has come down from the days of wooden shipbuilding. It was the name given to a wooden pin or plug driven between the two surfaces of a joint, usually at a corner, and intended to stop off or prevent the water from passing into the joint beyond. Thus a stopwater was often driven into the joint of a keel scarf in order to prevent the water from passing in between the inner surfaces. For a similar reason a stopwater was usually fitted in the joint between the stern post and keel. The term is still occasionally used in reference to any pin or key or similar device for stopping off or preventing water from traveling along a joint or seam. See the article on this subject in this issue.

Q. 118.—Would you give me a rule for finding the horse power of a marine engine, high-pressure cylinder 13 1-2 inches; intermediate, 21 inches; low, 34 inches; stroke, 21 inches; revolutions, 280 per minute; steam, 225 pounds; vacuum, 25?

J. C.

A.—The rule for finding the power from the data given would be the usual horse-power rule, as follows: Multiply the mean effective pressure reduced to the low-pressure piston by the area of the l. p. piston in square inches and by the piston speed in feet per minute, and divide the product by 33,000. The area of the l. p. piston is 908 square inches. The piston speed is $2\times21\times280\div12=980$. The mean effective pressure reduced to the low-pressure piston cannot be found in any such simple manner. It is this factor which would be furnished by indicator cards, if such were at hand. In their absence we must resort to such assumptions as seem reasonable, and compute the probable value in this way. This may be done by the aid of the following formula:

$$p=f\left(p_1\frac{1+\log r}{r}-p_2\right)$$

where p_1=absolute pressure at boiler, p_2=back pressure on exhaust side of low-pressure cylinder, r=expansion ratio, and f=a factor which, for triple-expansion engines, may be taken at about .65. Regarding the value of r we must remember that the total expansion may be considered in two parts, that in the high-pressure cylinder and that between the high-pressure and the low-pressure. The point of cut-off in the high-pressure is not stated, but if it is taken at about .60, and if we take about 15 per cent. clearance, the expansion in the high-pressure cylinder alone will be $(1.00+.15)\div(.60+.15)$ or $1.15\div.75=1.53$. Then the expansion between the high-pressure and the low-pressure will be as the areas, or as the squares of the diameters. This will give a ratio of $(34)^2\div(13.5)^2=1156\div182=6.35$. Hence, the total probable expansion ratio of the steam will be $6.35\times1.53=9.7$. We must next find the natural logarithm of this number, which may most readily be taken from a table, or, if such table is not at hand, we may take the common logarithm and multiply by 2.304. We thus find the natural logarithm of $9.7=2.2721$. We next take for p_1 the absolute pressure at the boiler with proper allowance for drop in steam pipe. The absolute pressure at the boiler will be $225+15=240$, and, allowing 10 pounds drop, we shall have at engine $p_1=230$. For p_2, the back pressure, we will take 3 pounds, corresponding to a pressure slightly above that for 25 inches of vacuum. We may now substitute in our formula and find as follows:

$$p=.65\left[\frac{230\times3.2721}{9.}-3\right]=48.5$$

Now substituting in the horse-power rule we have

$$\text{I.H.P.}=\frac{48.5\times908\times980}{33,000}=1308$$

The result thus obtained is simply an estimate based on what might be expected with steam pressure and revolutions as stated, and with steam ports and passages of size suitable to maintain the pressure without serious loss by wiredrawing.

Q. 119.—Will you please answer the following through your paper: Describe in detail what is now considered the most improved method of testing a new boiler for strength, and in order that the same condition may exist, as nearly as possible, as when the boiler is in actual use, and to avoid undue shock and strain on the boiler.

2. Describe how you would test an old boiler in place on board a ship, with the conveniences usually found on board.

J. S. S.

The test pressure enforced by the United States inspection rules is one and one-half times the working pressure desired. The method of applying the test is by water under pressure, and it is not practicable to realize fully the conditions under which the boilers operate when under steam. If the water can be pumped in regularly and without developing serious fluctuations of pressure, the boiler should receive no harm, and the purposes of the test should be safely and satisfactorily realized.

To prepare a boiler for such test, the springs should be removed from the safety valves and a length of pipe or other rigid strut substituted, so that the valves may be screwed down fast. All stop valves, cocks, gage-glass connections, etc., should then be tightly closed, except such as may serve to admit the water and to register the test pressure employed. While the test is progressing the boiler should be subjected to the most careful examination inside and out. The furnaces, combustion chambers, and back-tube sheets may be examined from the inside, and the shell, with its various joints and seams, from the outside. As small leaks develop they are stopped by calking, if possible, or, if about the tube ends, by re-expanding. Especial watch must be made for any signs of bulging, buckling, or other deformation. When especial care is to be taken gages are provided in the furnaces and combustion chambers and on the shell. These will serve to indicate or to measure the actual amount of distortion resulting from the gradually increasing pressure. If the distortion or bulging at any point should seem to be unusual, the pressure should be relieved by letting off a little water or by stopping the pump and allowing it to escape by leakage, in order to see if any permanent set has been made. In a thoroughly satisfactory test, all gages should return to the original setting when the pressure is finally removed, showing no permanent set at this point. It will not usually be found possible to tighten the various valves so that there will be no leakage, and an idea of the amount of such leakage may be obtained by noting the rapidity with which the pressure-gage pointer moves backward when

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the pump is stopped, or by the amount of pumping required to maintain the pressure at its full value. The gage pointer will also indicate, by a more or less sudden movement backward, the development of leaks at any points, should such occur.

The fundamental purpose of the test is twofold: To develop leaks or weakness. If the leaks in the joints are only small and such as may be controlled by calking, and if there is no evidence of undue distortion, and if the gages return to their original setting, the test may be considered as satisfactory in all respects.

In some cases the water test has been carried out by filling the boiler and then lighting wood fires in the furnaces. The expansion of the water will furnish the increase of pressure desired, which may be eased by a valve or cock as necessary. While the boiler in such a case is more nearly in its regular service condition, still the actual steaming conditions are far from being fulfilled, and the furnaces, combustion chambers, and back-tube sheet are not available for examination during the test. The pressure is also under less definite control than by the pump method, and, on the whole, the latter is now usually preferred.

In testing an old boiler on board ship, as nearly as possible the same general routine as above should be carried out. Many of the details would depend on the appliances and means available. The principal trouble might be with the means of getting the pressure. With an auxiliary boiler on board, on which a pressure may be carried somewhat higher than that regularly carried on the main boiler, it may be possible to get the test pressure needed by the feed pump operated from this boiler. If not, then some form of hand-test pump must be provided. The principal difficulty with the latter is that with such leaks as are liable to develop in the joints, seams, and connections, when under the test pressure, it may be difficult with the hand pump to maintain the pressure. It will, at least, however, serve to develop the leaks, and as they are gradually stopped, it will be possible to hold more continually the pressure by the small pump.

Q. 120.—Would you please work out for me the following information: In a cylindrical return tubular boiler 12 feet diameter, pressure 150 pounds, two plain furnaces 40 inches diameter, 6 feet long, made of mild steel with tensile strength of 60,000 pounds to withstand a working pressure of 150 pounds, I would like to know the following particulars:

1. Thickness of shell.
2. Thickness of furnace.
3. Size and spacing of stays.
4. Diameter of rivets.
5. What would be the thickness of corrugated furnace for above boiler? Corrugations being 6 inches pitch, furnace diameter 7 feet 6 inches long.

The factor of safety is to be 4 1-2, the strength of joint 80 per cent. of the plate, and the shell is to be increased 1-16 inch for corrosion. A. F.

A.—The thickness of shell may be determined by the formula,

$$t = \frac{pD}{2T}$$

in which p is the pressure in pounds per square inch, D the diameter in inches, and T the safe working strength. Since the factor of safety is to be 4 1-2 and the strength of joint is estimated at 80 per cent. of the plate, the value of T will be found by taking 80 per cent. of 60,000 and dividing by 4.5. This gives 10,666. We have, therefore, for the thickness of shell

$$t = \frac{150 \times 144}{21333} = 1.01$$

To this we add 1-16 of an inch for corrosion, giving T=1 1-16 inches.

If the furnace is to be entirely plain, that is, without corrugations, Adamson rings, or other similar support, the thickness as given by the United States rule would be as follows:

$$t^2 = \frac{LDp}{89600}$$

in which L=length in feet, D=diameter in inches, and p = pressure. Hence we have:

$$t^2 = \frac{7.5 \times 40 \times 150}{89600} = .5, \text{ or } t = 3\text{-}4 \text{ inch nearly.}$$

This is entirely too thick for such service, and such a type of furnace should never be employed in a boiler of this character. For the corrugated furnace, the thickness by the United States rule would be as follows:

$$t = \frac{Dp}{15000} = \frac{40 \times 150}{15000} = .4 \text{ inch}$$

or say 7-16 inch.

The size and spacing of stays will depend upon the details of the fitting. The combustion chamber plates might be made 1-2 inch thick, with screw stays spaced 7 inches by 7 inches, and 1 1-8 inches diameter at bottom of thread if steel, or 1 1-4 inches if iron. The head stays may be spaced about 15 inches by 15, and should be about 2 1-4 inches diameter at the smallest section. The upper heads may be made either 1 inch thick and without washers or other reinforcements for the stay nuts, or 3-4 of an inch thick with washers fitted in accordance with the United States Rules.

Regarding the riveted joints, the longitudinal shell joints should be double butt-strapped and triple-riveted, with the rivets double-spaced in the outer row on each side. With such a joint, using 1 1-8-inch rivets, the pitch in the outer row would be about 8 inches and in the inner rows about 4 inches. The distance between the middle and inside rows would be about 3 1-2 inches, and that between the middle and outside rows about 4 inches. The circumferential joints should be double-riveted, with a spacing of about 2 3-4 inches in each row.

Regarding various details in connection with the design of such a boiler, you may be referred to the United States Rules prescribed by the Board of Supervising Inspectors of Steam Vessels, a copy of which may be obtained on application to the Treasury Department, Washington, D. C.

Q. 121.—I wish to take up a short course in mechanics and would like to know if you will give me the names of one or two elementary books for study. I am a salesman in a steam specialty house and would like to have some technical information. My time is so much taken up that I cannot devote over six or eight hours a week to study. W. R.

A.—Assuming that you would prefer books on Mechanics which do not require a knowledge of differential and integral calculus, and such books as treat the subject in a plain and simple manner and as far as possible without the use of higher mathematics, a selection among the following may be suggested: Culverwell, E. P., *Elementary Mechanics;* Dana, E. S., *A Text Book of Elementary Mechanics;* Lock, J. B., *Elementary Statics;* Lock, J. B., *Dynamics for Beginners;* Magnus,

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Sir Philip, *Lessons in Elementary Mechanics;* Peck, W. G., *Analytical Mechanics;* Alexander, T., *Elementary Applied Mechanics.* Part I. These books are not expensive, averaging only a little over $1 each, and may be obtained from any dealer in technical books, or, if desired, through MARINE ENGINEERING.

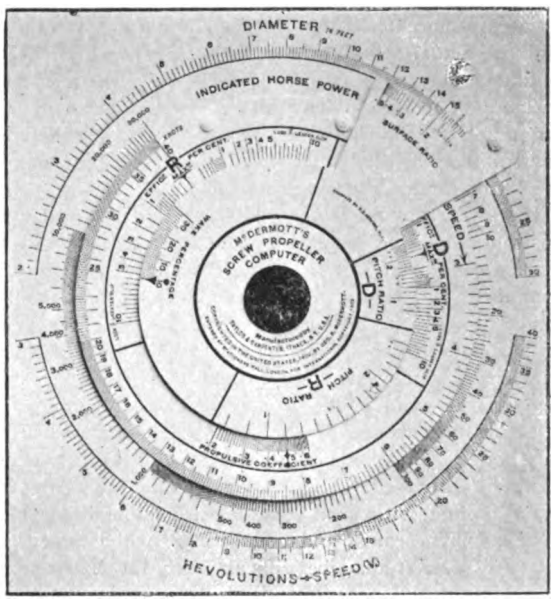
TECHNICAL PUBLICATIONS.

Screw Propeller Computer. By G. R. McDermott, Professor of Naval Architecture, Cornell University. A special form of disk slide rule, with leather cover, 7 inches by 7 1-2 inches, with text separately bound, pp. 52, giving a brief discussion of the resistance and propulsion of ships, and directions for the use of the computer. Price $5. Taylor and Carpenter, Ithaca, N. Y.

There is perhaps no problem with which the naval architect or marine engineer is concerned which presents so many difficulties as that involving the intelligent design of a screw propeller to fulfill a given programme of conditions, or the analysis of the performance of a propeller with a view to determining the relative efficiencies of the various component features. This is due chiefly to the intricate manner in which the various items are interrelated, and the difficulty of expressing in any simple formula or manner the operations necessary to carry out the various computations involved in the solution. From the very nature of the case, the foundation must be experimental, and the experiments of Froude have long served as the general foundation for various methods of computation involving the use of formulæ and tables giving values of various empirical factors. It is with a view of substituting for these numerical operations the mechanical operation of the slide rule, with its well-known saving of time and mental effort, that the author has brought out this special form of computer. By its means the various dimensions and proportions of propellers—diameter, pitch, revolutions, surface, efficiency, and slip—may be quickly determined and with the same degree of accuracy as inheres in the use of the fundamental experiments by Froude and others. Regarding the question of accuracy or reliability, the general use during the past fifteen years of these experiments, with the satisfactory results which they have given, has proven the general applicability to such cases as arise in the various classes of service, naval, mercantile, and pleasure. The purpose of the computer is, therefore, to substitute for the arithmetical computations the use of the slide rule, and to reproduce in this way the results which, by numerical work, would result from the use of the various equations and formulæ which have been proposed.

In addition to the various slide-rule scales by means of which the computations are effected, and regarding the use of which full instructions are given on the inside cover of the case, the explanatory text of 52 pages gives a brief and succinct discussion of the problem of resistance and propulsion, especially from the point of view of propeller design and analysis. Resistance, race rotation, cavitation, the wake, augmentation of resistance, effective horse power, thrust horse power, propeller horse power, indicated horse power, true and apparent propeller efficiency, propulsive coefficient, mechanical efficiency of engine—these and collateral topics are briefly discussed and their relations to the main problem developed, with a number of illustrative examples.

This computer should prove a most acceptable addition to the office equipment of the naval architect or marine engineer, as by its use he will be able to save the time involved in many tedious computations and arrive quickly at the results desired. In this connection a further point of importance may be noted. This is, that with the slide-rule scales there is presented to the eye not only the actual solution desired, but the ready determination of the results due to slight departures from the original conditions. In this manner the consequences of any slight variation from the original conditions are readily observed.



MCDERMOTT'S PROPELLER COMPUTER.

Mechanically, this computer seems to be most carefully and accurately made; the engraving is clear and well executed, and the printing, binding, and entire make-up of the computer and explanatory text leave nothing to be desired.

Speed of Warships.—An opportunity was given in the assembling of the United States squadrons in the Caribbean Sea for a test of speed of several of the warships. On November 15 the four battleships, the *Alabama, Kearsarge, Massachusetts, Indiana,* and the gunboat *Machias* sailed from Hampton Roads under orders to proceed at full speed to Culebra Light. The *Alabama* led the squadron of battleships the entire distance, and her strongest competitors were the *Massachusetts* and *Kearsarge.* After four hours the *Alabama* left the *Kearsarge* hull down, and a little later the *Massachusetts* was left behind. The cruiser *Cincinnati* started thirty-five miles behind the squadron, and came up with the *Alabama* on the second day out. The two vessels had a close race for over two days and arrived at the Light with the *Alabama* leading by two miles. Under natural draft her average speed had been 15.2, and under forced draft for four hours 16.65 knots.

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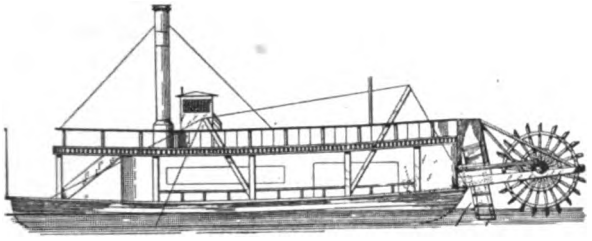
SELECTED MARINE PATENTS.

713,063. STEERING AND MANŒUVERING WHEEL FOR VESSELS. SAMUEL W. COFLIN, COVINGTON, KY., ASSIGNOR OF NINE-TENTHS TO OSCAR J. COFLIN, COVINGTON, KY.



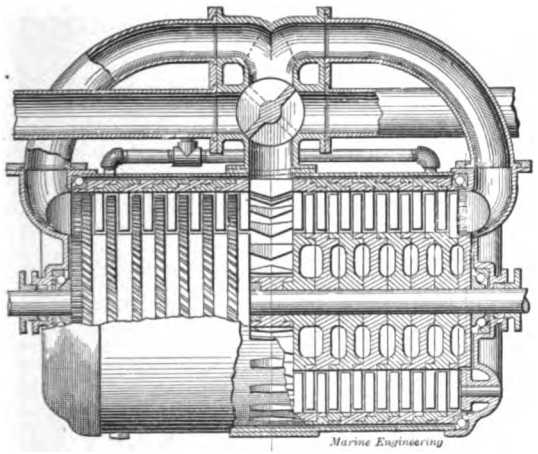
Claim.—1. A steering wheel for a vessel, consisting of paddles carried on a shaft and supported so as to be capable of rotation at right angles to the direction in which the vessel travels when moved by the means provided for its propulsion, said shaft inclined with reference to the hull of the vessel and the outer edges of the paddles inclined with reference to the shaft, and means for rotating this steering wheel and for controlling its operation. Three claims.

713,095. STEAM TURBINE. JOHN A. HELLWEG, MILWAUKEE, WIS. Four claims.

713,198. TORPEDO BOAT. FRANCIS W. BRADY, ENGLEWOOD, N. J., ASSIGNOR TO ELECTRIC BOAT COMPANY, NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

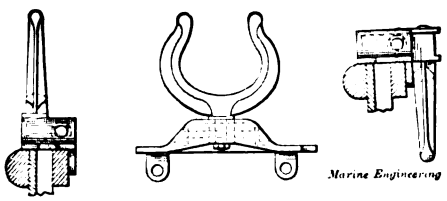
Claim.—1. A means for controlling the expulsion of torpedoes, comprising an expulsion tube, a cap which closes the outboard end of said tube, means for operating said cap, a firing valve or mechanism for controlling the expulsion of the torpedo, an automatic lock to prevent the operation of said firing mechanism, and means controlled by the cap-opening mechanism which sets the said lock so that it may be operated to unlock the firing mechanism. Seven claims.

713,261. STEAM TURBINE. MORRIS M. WHITAKER, SACKETT HARBOR, N. Y., ASSIGNOR OF ONE-HALF TO WILLIAM R. SANDS, NEWARK, N. J.



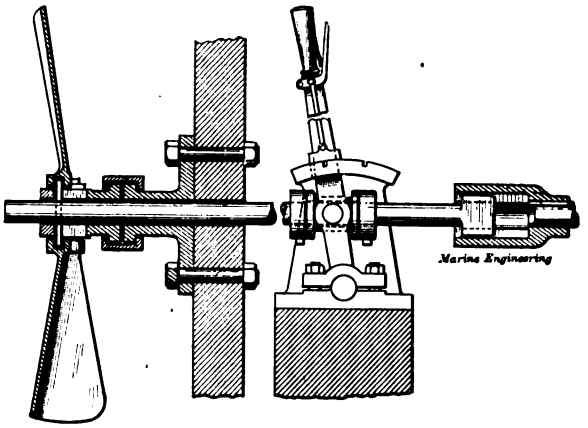
Claim.—1. In a turbine the combination with a casing having inlet and outlet passages, and a shaft journaled in the casing, of a revoluble core mounted on the shaft having blades arranged at an angle thereto, a drum journaled in the casing surrounding the core and provided with blades extending between those upon the core and extending at an angle to said blades, gear wheels upon the revoluble parts and pinions arranged within the casing and between said parts. Sixteen claims.

713,551. FOLDING OAR LOCK. JOHN M. BIRTELS, CASS LAKE, MINN., ASSIGNOR TO MICHAEL L. TOOLE, JACOB E. JOHNSTON, ANNA KENNEDY, JAMES E. NELSON, AND JAMES CARDLE, CASS LAKE, MINN.



Claim.—1. In a folding oar lock, a supporting base having a hollow upwardly-projecting central portion with a transverse opening through its top and one side, a block projecting through said transverse opening and having lateral studs engaging the interior of said central projecting portion and affording partial support to said block, a pivotal pin passing through said studs and said block and secured by its ends in said projecting portion, and an oar lock pivotally secured in said block. Three claims.

713,441. PROPELLER. SAMUEL IRWIN, LINDSAY, CANADA.



Claim.—1. The combination of a box, a hub juxtaposed thereto, said parts being formed with annular flanges, a collar enclosing said flanges rotatably to connect the hub to the box; propeller blades adjustably mounted on the hub, a shaft longitudinally movable through the box and hub, and a connection between the shaft and the propeller blades. Three claims.

713,454. MARINE VESSEL. FREDERICK A. KNAPP, PRESCOTT, CANADA.

Claim.—1. In a marine vessel, the combination of a central tube; an inner skin; and an outer skin suitably connected and arranged to form an annular air space between the two skins and annular cargo space between the inner skin and the central tube. Seven claims.

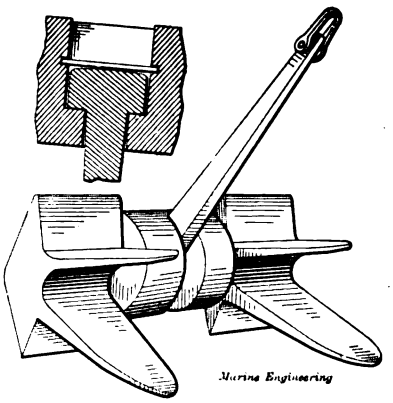
713,651. BALLAST-UNLOADER. GEORGE W. KING, MARION, OHIO, ASSIGNOR TO THE MARION STEAM SHOVEL COMPANY, MARION, OHIO, A CORPORATION OF OHIO. Nine claims.

713,785. MARINE PROPULSION. OLUF E. MEYER, MILWAUKEE, WIS.

Claim.—1. In a marine propeller, cranked shafts secured in bearings at either side of a vessel and parallel with the keel thereof, spiral blades having a plurality of turns throughout the length of said shafts and secured to the latter, openings in the sides of the vessel below the water line thereof and opposite the cranks in the aforesaid shaft. Three claims.

713,797. DETACHABLE DECK FOR MARINE VESSELS. JOSEPH W. POWELL, FARNHAMVILLE, IOWA. Three claims.

713,825. ANCHOR. JOHN WICK, CHESTER, PA., ASSIGNOR OF ONE-HALF TO WILLIAM P. TODD, CHESTER, PA.



Claim.—1. An anchor comprising a shank and a head or body pivotally connected with the shank and capable of a limited rotary movement, said head or body being provided at each side with a pair of diverging flukes arranged to be carried to either side of the shank by the said rotary movement, whereby one fluke of each pair will embed itself in the bottom and the other fluke will lie upon the surface of the bottom, substantially as described. Five claims.

713,830. BOAT. SYLVESTER S. YORK, PORTLAND, ME., ASSIGNOR OF ONE-HALF TO CHARLES W. YORK, EAST BOSTON, MASS.

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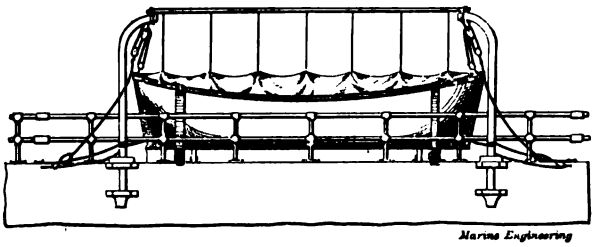
Claim.—1. A boat provided with a keel board pivoted on a longitudinal axis and extending on both sides thereof and weighted to bring its center of gravity below its pivot, and means for positively moving said board into different angular positions.

2. A boat having a recessed keel and provided with a keel board, said keel board being pivoted on a longitudinal axis within said recess and extending on both sides of said axis and weighted to bring its center of gravity below its pivot, said board being adapted to lie with its edges either at equal or at different elevations with respect to the boat hull.

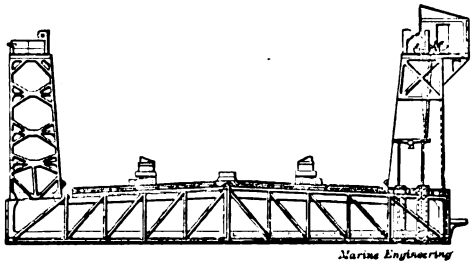
713,889. APPARATUS FOR LOWERING LIFE BOATS. ANTONIO KERSUL, NEW YORK, N. Y.



Claim.—1. An apparatus for lowering life boats, consisting of two rotatable davits, a drum on each davit, means for supporting the boat on the deck of the vessel, a lowering rope or fall connected with each davit and with the boat, and a davit rope for each davit passing over the drum of the same and connected with a bight of said lowering rope. Seven claims.

713,920. TURBINE. JAN PROCNER, PABIANICE, NEAR LODZ, RUSSIA. Three claims.

713,947. FLOATING DRY-DOCK. GASTON A. BRONDER, BROOKLYN, N. Y.

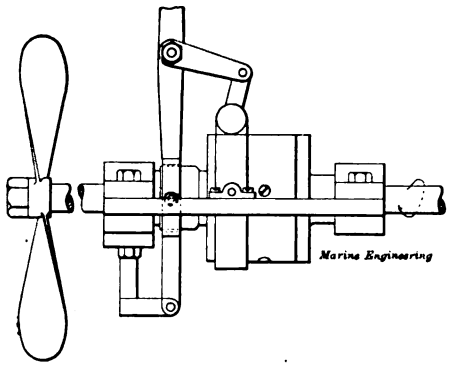


Claim.—1. A pontoon consisting of the combination of a metallic framework, wooden stringers bolted thereto constituting a wooden frame on the outside of the steel framework, planking spiked to said stringers, and means for compressing the planks against each other.

2. In a pontoon consisting of steel frames, a wooden frame bolted on the outside of the steel frames, planking spiked to the wooden frame, gutters taking the place of some of the planking and bolted to the pontoon. Five claims.

714,193. BALLAST UNLOADER. GEORGE W. KING, MARION, OHIO, ASSIGNOR TO THE MARION STEAM SHOVEL COMPANY, MARION, OHIO, A CORPORATION OF OHIO. Eight claims.

714,197. REVERSING GEAR FOR PROPELLER SHAFTS. ALBERT L. KULL, CAMDEN, N. J.



Claim.—1. In a reversing gear, a divided shaft, gears mounted on the abutting ends of said divided shaft, gears meshing at right angles with the shaft gears, a housing enclosing all of said gears and forming a pivotal support for the meshing gears, said housing and meshing gears normally rotating around the shaft gears, a band having a cam surface, a bolt having a cam-shaped head adapted to engage said cam surface to clamp said band to said housing for breaking the rotary movement of the housing whereby the motion of one shaft gear may be transmitted through the meshing gears to the other shaft gear to turn said gear in an opposite direction, and means for locking one abutting end of the shaft directly to the housing when said housing normally rotates. Four claims.

714,499. APPARATUS FOR COALING SHIPS. FREDERICK V. MATTON, CAMDEN, N. J. Two claims.

714,627. STEAM TURBINE. ROBERT WILSON, SCHENECTADY, N. Y. Two claims.

714,757. LIFE-SAVING APPARATUS. JOHN STRAKELE, NEW YORK, N. Y., ASSIGNOR OF ONE-THIRD TO JOHANN MARTIN SCHWENK, NEW YORK, N. Y. Six claims.

714,766. CONVERTIBLE BOAT-PROPELLING APPARATUS. JAMES WHITESIDE, NEW YORK, N. Y. Two claims.

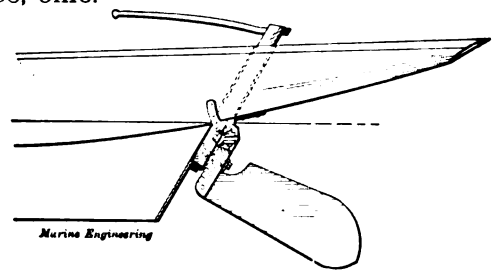
714,921. STORAGE OF SUPPLIES FOR SUBMARINE VESSELS. SIMON LAKE, BRIDGEPORT, CONN. Seven claims.

Claim.—1. A submarine boat comprising a hull shaped to resist the external water pressure during submergence and means for closing the same water-tight from the exterior, means for propelling the same including a heat engine, a fuel tank or reservoir carried by said boat exterior to and upon the upper side of the said hull, and a connection from said fuel tank or reservoir through the wall of the hull to the said heat engine. Seven claims.

715,013. PROCESS OF TREATING THE OUTSIDES OF SHIPS, ETC., FOR MAKING THEM LESS VISIBLE. GEROME BRUSH AND ABBOTT H. THAYER, DUBLIN, N. H.

Claim.—1. The method of making an object less visible, which consists in giving to that part of the surface of the object which would reflect the most light a comparatively dark color and to that part which would reflect the least light a comparatively light color, so as to prevent the existence of contrasts of light and shade. Three claims.

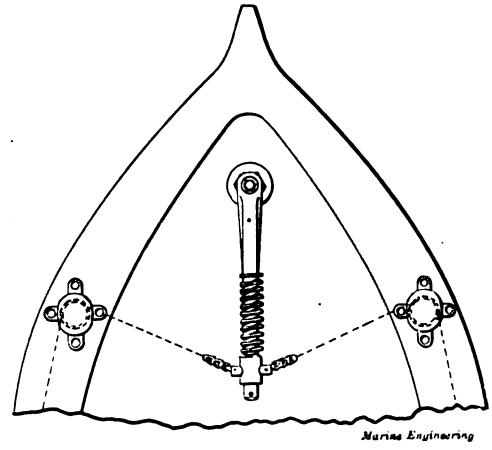
715,176. YACHT RUDDER. GEORGE W. SWAN, TOLEDO, OHIO.



Claim.—1. In a rudder, the combination with the rudder post, of a rudder blade pivoted thereto at an angle to the axis thereof, and means for turning the rudder blade upon its angular axis, simultaneously with the turning of the rudder post.

2. A rudder for sail yachts comprising a rudder post, a rudder blade pivoted at the lower end of the post, a segmental gear upon the blade, and a segmental gear secured upon the hull of the yacht adapted to engage the gear upon the blade, as shown.

715,193. STEERING GEAR. GEORGE A. BURWELL, PLATTSBURG, N. Y., ASSIGNOR TO THE LOZIER MOTOR COMPANY, PLATTSBURG, N. Y., A CORPORATION OF NEW YORK.



Claim.—1. In a vessel, the combination with a tiller and steering chains, of a coiled spring mounted on said tiller and having one end fixed to said tiller, the other end being in operative relation with said steering chains.

2. In a vessel, the combination with a tiller and steering-chains, of a coiled spring mounted on said tiller and having one end fixed to said tiller, and a sleeve loosely mounted upon said tiller and in operative relation with said spring and steering chains.

715,191. DUPLEX PROPELLER. HUGH B. ALLISON, DES MOINES, IOWA.

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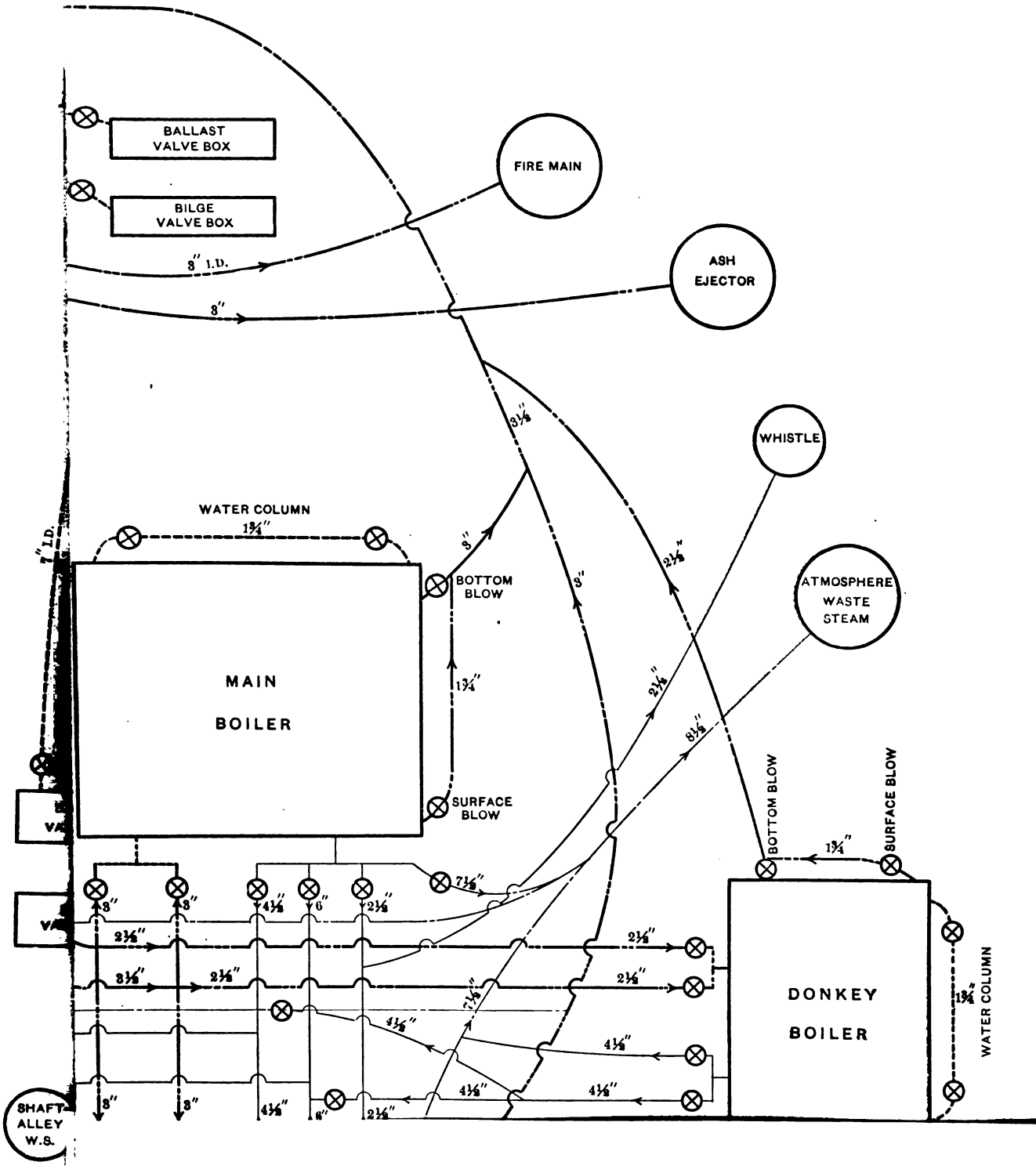

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Marine Engineering

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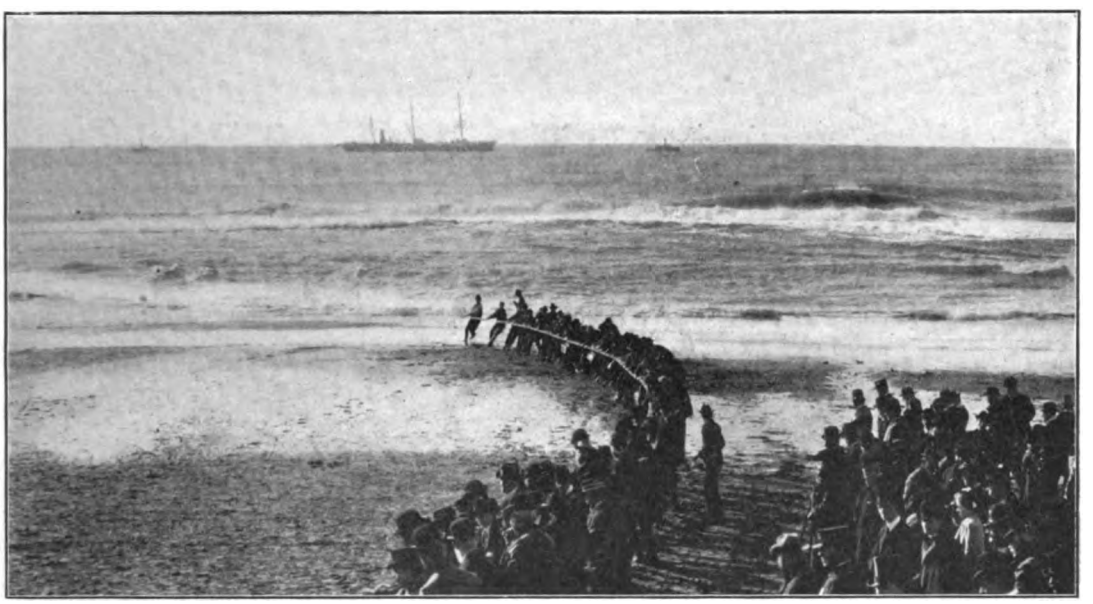
THE NEW PACIFIC CABLE FROM SAN FRANCISCO TO HONOLULU, HAWAII.

BY WILLIAM H. CRAWFORD, JR.

At 2 o'clock on the morning of December 15 the big cable ship *Silvertown* left a point about six miles off the Golden Gate, San Francisco, and started on her long voyage of cable-laying to Honolulu, Hawaii. Although these interesting operations have been attracting attention off and on since the days of the first Atlantic cable in 1858, until nearly every corner of the world is now reached by telegraphic connections, particular significance attaches itself to this venture, for it is probably the last important link to be made in the world's history of this universal intercommunication. With the advent and rapid development of wireless telegraphy it seems almost as though this operation was undertaken none too soon, if those interested wished to push their original idea through to completion in time to get some financial return for the money invested.

The cable ship *Silvertown*, a veteran at the business, was the boat selected by the contractors to do this work for the Pacific Commercial Cable Company. It is said that away back in 1873, when this boat was built, the officials of the India Rubber, Gutta Percha, and Telegraph Works Company, her owners, drew on a card three large circles representing as many tanks for holding coiled cable, and that they handed the card to the shipbuilders with these instructions, "Build us a ship around these tanks"; and seeing the *Silvertown*, the story is easy of belief. Viewed from a distance, she is an awkward-looking craft, something after the style of the grain carriers of the Great Lakes. She has cumbersome apparatus at the bow and stern where the "paying-out" and "picking-up" machinery is located. Everything, of course, has been sacrificed to best suit the great work for which she was intended, although it is only fair to state that within she is as snug as a private yacht, providing every possible luxury for the 32 officers and 127 men that go to make up her crew and the cable-laying force.



ATTEMPTED LANDING OF THE NEW PACIFIC CABLE, GOLDEN GATE, CAL., DECEMBER 12, 1902.

The *Silvertown* came out to San Francisco from London in seventy-five days and brought coiled up in her hold 2,413 nautical miles, or 4,807 tons, of submarine cable in the three big tanks. During the long voyage out, Henry Benest, engineer-in-chief of the expedition, was sending and receiving messages to himself, telegraphed from one end of the cable to the other as it rested in the ship's hold—this to quickly determine if there was any deterioration in the cable's insulation, due to heat or other causes. The three massive tanks about which the ship is built are located forward of the engine and boiler room space. The main tank is 53 feet in diameter and 31 feet 11 inches in depth, the forward tank is 46 feet in diameter, and the after tank 51 feet diameter. In the center of each tank is a hollow hub in which surplus lengths are stored, and around this hub, like thread on a spool, the cable is tightly wound.

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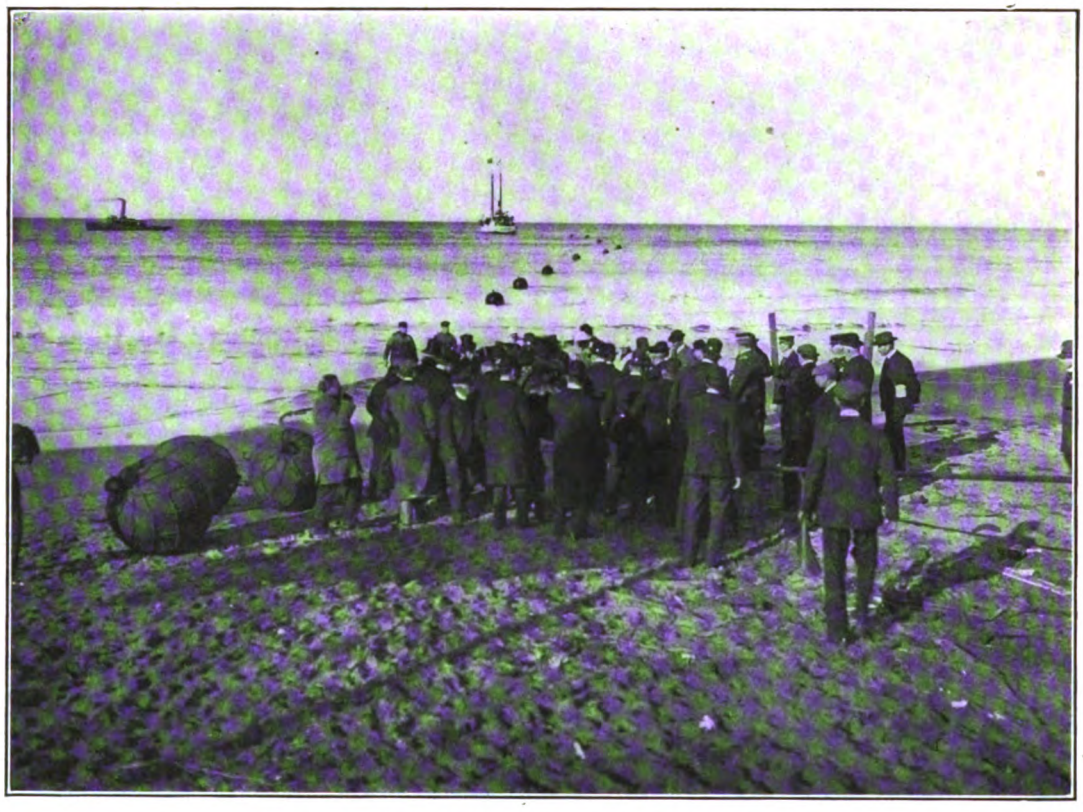
The "paying-out" gear consists of a large revolving drum located on the after deck, starboard side, and around which the cable is passed four or more times. The speed of this drum is regulated by automatic governors and it is driven by a heavy set of engines, being kept at a speed slightly in excess of the overground gait of the vessel, to allow for the irregularity of the submarine landscape. The actual overground distance from San Francisco to Honolulu is 2,099 nautical miles, while the cable is estimated to cover 2,413 nautical miles of the great valleys and mountains that make up the bed of the Pacific. Guide wheels conduct the cable after it leaves this drum under the dynamometer pulley and from there to the stern sheaves. A large scale above the dynamometer pulley indicates at all times in hundredweights the strain on the cable, and hence the automatic regulation of the paying-out speed.

If all goes well this ship makes between six and seven knots per hour while paying out cable, and the operation is continuous until the end of the journey is reached, unless bad weather is encountered, in which case the cable is cut, the end buoyed and thrown overboard, while the ship looks out for herself. When conditions are again favorable she returns to the spot, and after regaining the lost end a splice is made and the journey continued. As the cable is exhausted from one tank the loose end is secured and spliced to the end of the cable coiled in the next tank, this being done in plenty of time, so that no delay is occasioned when the transfer is made from one tank to the other.

The "picking-up" or lifting gear is forward at the forecastle head and is used to recover the cable should it need repairing or be lost in rough weather.

On Friday, December 12, after lying in the harbor for a week, the *Silvertown* steamed out through the Golden Gate and came to an anchorage half a mile south and about 1 1-4 miles off shore. This was about 8 o'clock A.M., and immediately preparations were begun for getting a line ashore. The life-saving crews from Fort Point and South Side were out in their boats, in case of any trouble, and the Golden Gate crew had a position on the beach directly in line with the proposed landing place, their boat on its truck all ready for launching in case of emergency. It is estimated that between 30,000 and 40,000 people assembled to view the operation, the occasion being one of general interest. It was soon seen that the strong back tide running out through the Gate was turning the *Silvertown* around out of position, so the services of a powerful wrecking tug were engaged to pass a line to her stern and hold her in position against the tide. A heavy ground swell that had been running all morning made the big ship roll around in a threatening way and delayed until quite late the landing of a line from her. At last, however, the Golden Gate life-saving crew received a signal at their stand on the beach to launch their boat and bring the line ashore. This was accomplished with some little difficulty; however, the one-inch rope was at last made fast to the team of twelve horses that awaited it on the beach. This rope was used to bring



SUCCESSFUL LANDING OF THE PACIFIC CABLE, DECEMBER 14, 1902.

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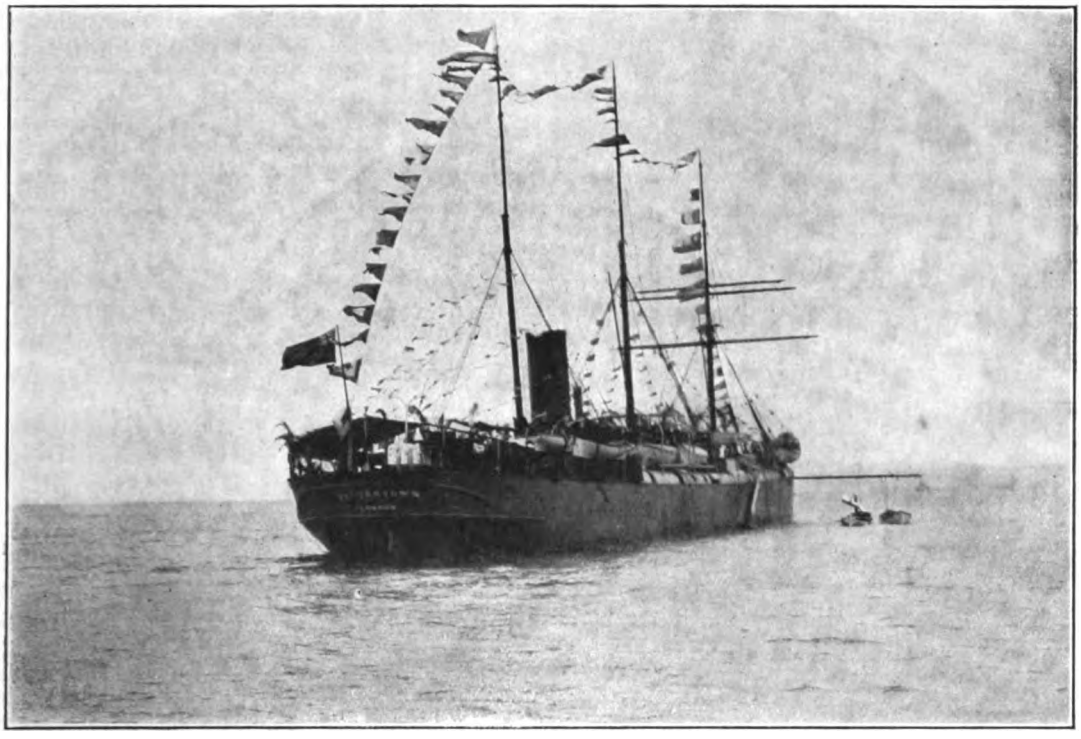
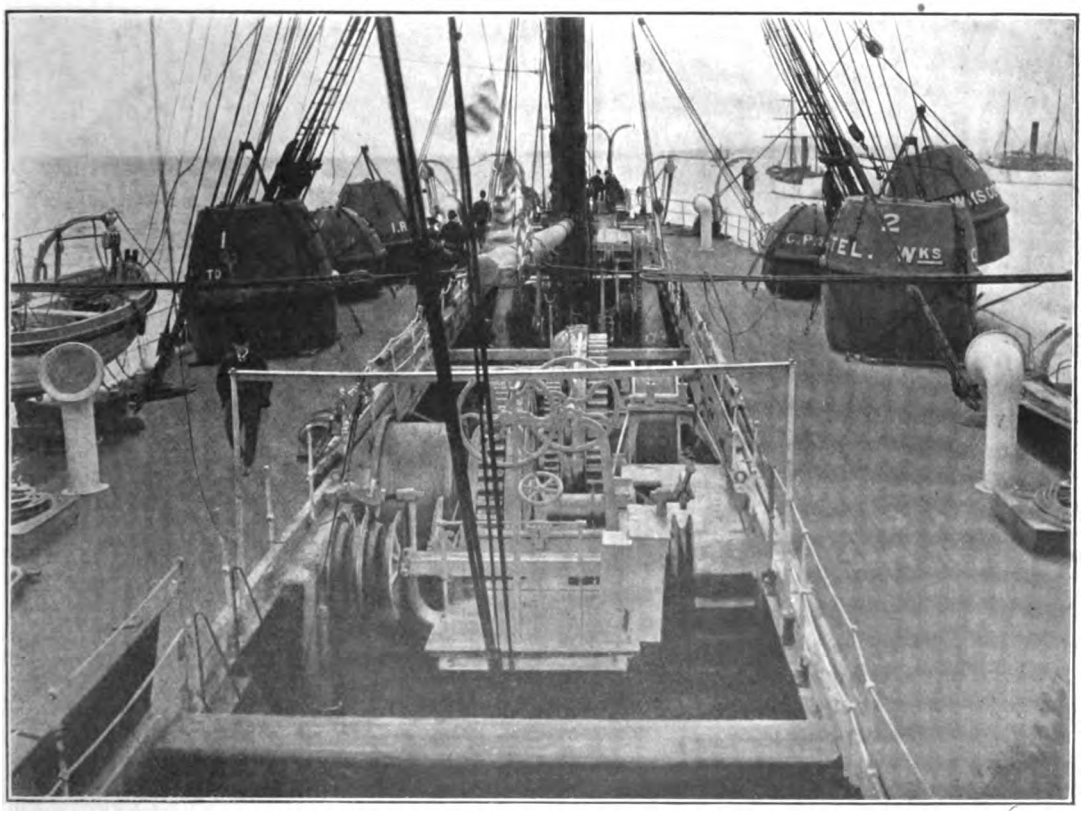


THE CABLE SHIP SILVERTOWN, USED IN LAYING THE NEW PACIFIC CABLE.



DECK VIEW ON THE SILVERTOWN, LOOKING FORWARD.

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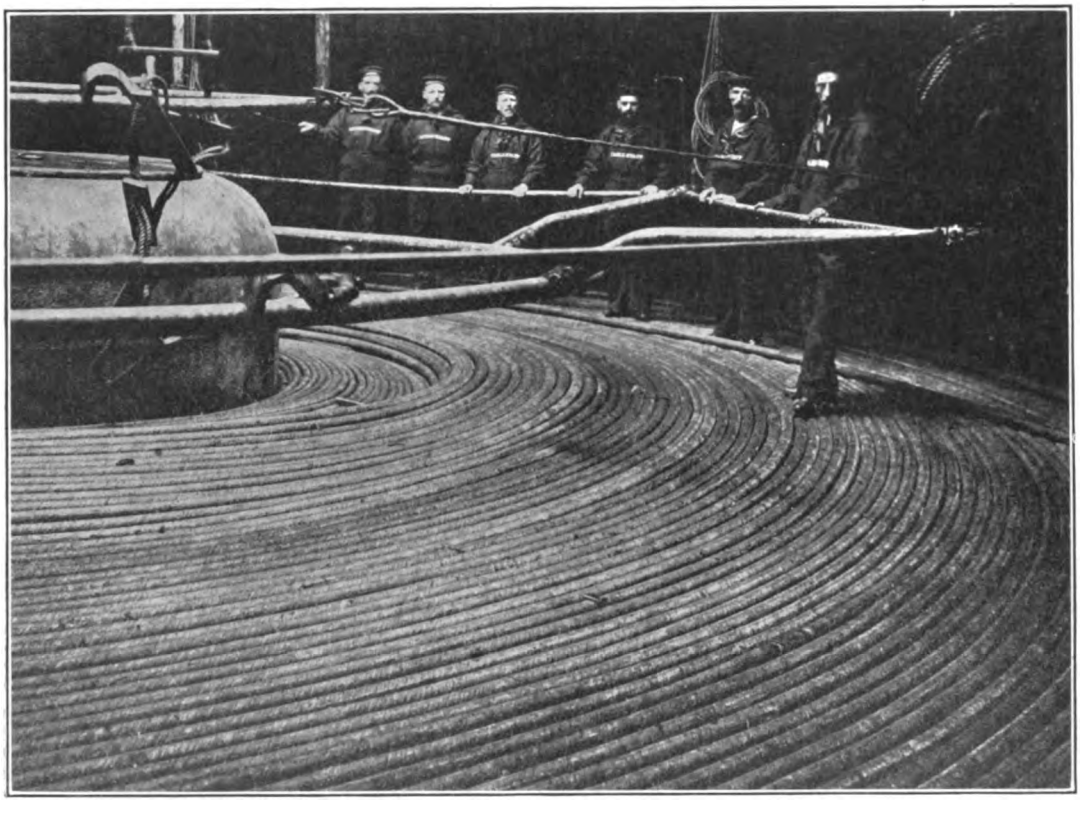
a heavy two-inch rope ashore, and then the actual landing of the cable began. Over 300 feet were paid out from the stern of the *Silvertown*, with large canvas air bags attached every few feet to float it, when it was seen that the strong current was carrying the cable away out of its course and making it almost impossible for the big team of horses on shore to move it. Darkness was coming on and the big cable ship rolling so hard that her position was really not one of safety, so the message was flagged ashore from the ship that operations must be suspended. The cable and rope were pulled back on board, and the *Silvertown* left her dangerous position, steaming in through the Golden Gate again to her original anchorage.

A new plan of campaign was then decided upon. It was seen that the assistance of a lighter-draft ship would have to be employed to land the shore end. Accordingly the steam schooner *Newsboy*, owned by the Gray Steamship Company, was chartered to take on board about six miles of the cable, the plan being for the schooner to land the shore end and then proceed to sea as far as the cable would reach, buoy the end and throw it overboard. The *Silvertown* would be nearby, pick up the end dropped by the *Newsboy*, and, after making the necessary splice, proceed on her way to Honolulu. This plan was carefully carried out on Sunday, December 14, the actual time of the landing of the shore end of the cable being 9:55 A.M., and the time that the *Silvertown* completed her work at the six-mile stopping place, before proceeding to sea, being, as before noted, 2 A.M. on the morning of the 15th.

When the *Newsboy* backed into into position about half a mile beyond the line of breakers, the light line was brought ashore as before, followed by the two-inch rope. This in turn was fastened to the cable, which was drawn to land without any difficulty, being floated by a great number of the canvas air bags, which held it suspended until, at a moment when all was in readiness, the bags with one operation were all released from their hold and floated around until picked up by the tugs in attendance. The same tidal difficulties that troubled the *Silvertown* then overtook the *Newsboy;* her anchors began to drag, and for a few moments she was in a bad fix. She was able to get under way at once, however, and soon straightened herself out on her course, proceeding to a point on the offing where the big cable ship could be seen hovering around.



HUB AND WINDING GEAR FOR CABLE IN THE HOLD OF THE SILVERTOWN.

The actual landing of the cable was made a great ceremony, the proverbial bottle of champagne being broken over the ragged end as it was drawn up on the sand, with the usual suggestive music from the bands in attendance.

After starting on her westward voyage the *Silvertown* sent daily reports to the cable station in San Francisco, and following is a memorandum of her daily runs:

To noon		Dec.	15	77	knots
"	"	"	16	180	"
"	"	"	17	196	"
"	"	"	18	207	"
"	"	"	19	203	"
"	"	"	20	189	"
"	"	"	21	215	"
"	"	"	22	211	"
"	"	"	23	197	"
"	"	"	24	217	"
"	"	"	25	215	"
"	4.A.M.	"	26	125	"

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At 4 A.M. on the 26th of December the *Silvertown* wired back that she was about to cut the cable and buoy it in the channel off Honolulu. From that time until 11 P.M. on New Year's Day no word was heard from the other end. At the latter hour, however, communication was established with the Hawaiian Islands by the announcement that all was well, the shore end landed, and final connections made.

The deepest place recorded in this route of the Hawaiian cable is 19,116 feet. That the *Silvertown* did not find her task entirely pacific is evidenced by the noonday report received on the 17th of December, when it will be noted her daily run fell below the average:

"In latitude 34 degrees 36 minutes north, longitude 129 degrees 59 minutes west; very bad weather; high seas; seas swept over decks; slowed down at intervals; indications of weather moderating; total cable laid at noon to-day, 455 knots; total for last 24 hours, in spite of storm, 196 knots; everything O. K."

Notes on Burning Crude Oil in Scotch Boilers.

BY H. S. MARKEY.

The distillers of crude oil tell us that when oil is subjected to destructive distillation a deposit of carbon or coke is left after the hydrocarbon gases have been driven off, just as when distilling soft coal in the gasworks.

When oil is atomized in the furnaces of a Scotch boiler, the gas is evaporated from the minute globules of oil, leaving a fine carbon dust, which must burn as carbon. The combustion of carbon proceeds somewhat slowly as compared with gas, but the more finely it is divided the quicker it will burn. Now, the burning carbon dust is carried by the draft with a certain velocity through the furnace toward the back connection, and it is evident that if it is not consumed quickly it will reach the back-connection sheet still burning. In other words, if the oil is not atomized thoroughly, it will burn with a long flame and may injure the back-connection sheet and stay-bolt heads. Again, if the carbon dust is not consumed while floating in the draft, it deposits in large, red-hot masses in the back connection, and must be dug out and thrown overboard—a manifest waste of fuel.

The more thoroughly the oil is atomized the finer will be the resulting carbon dust and the quicker it will burn, hence less chance for depositing and a shorter flame. This is the all-important function of the burner or atomizer—to thoroughly atomize the oil. The so-called retort burners or internal mixers are of doubtful value, except as they make for this important requirement. Either steam or compressed air may be used as an atomizing agent, one presenting no advantage over the other so far as the combustion is concerned. Steam is the more convenient, but the prohibitive cost of fresh water at sea necessitates the use of compressors or rotary blowers aboard ship.

Crude oil, when heated, becomes considerably thinner, in which condition it is more easily atomized. A good oil heater is therefore a necessary adjunct to oil-burning apparatus. When compressed air is used for atomizing, it should be heated to avoid the cooling effect upon the oil due to the sudden expansion of the air.

The velocity with which the oil is projected from the nozzle of the burner probably has more to do with pulverizing it than any other thing. The velocity depends entirely upon the pressure, hence that type of burner is superior which has the oil and steam or air pressure right up to the discharge orifice, the supply being regulated by the size of the orifice. Compressed air at from 20 to 30 pounds per square inch gives very good results, although pressures of one pound and less have been used. This low-pressure system, as it is called, with its resultant low velocity, cannot atomize the oil so thoroughly as the high-pressure system, and, in the only installation of the kind that has come under the author's notice, great trouble was experienced from the burning off of the stay-bolt heads and the buckling of the back-connection sheets. The only advantage that can be claimed for the low-pressure system is that it costs less to compress air to one pound per square inch than to compress it to 30 pounds, but the low-pressure system undoubtedly requires more free air to atomize a given quantity of oil than the high-pressure system, which goes a long way toward neutralizing any advantage in that direction.

On the Pacific coast we allow about one cubic foot of free air drawn into the compressor to each pound of water evaporated in the boiler. In some experiments with the low-pressure systems conducted by the United States navy, it was found that from 3 to 4 cubic feet were required.

It is not always easy to find room in the fire room for the cumbersome appliances of the low-pressure system, 15 to 18-inch riveted air mains contrasting strongly with the 4 to 6-inch gas pipe mains of the high-pressure system. More or less trouble has been experienced with the air compressors, it is true, but this was due to fitting compressors unsuited to the work. Machinery that will work well enough ashore does not necessarily give satisfaction at sea, where continuity of operation is all-important. It should be remembered, also, that the capacity of a compressor is measurable to a large extent by the area of the suction valve opening. Compressors with contracted inlets will deliver no more air at 100 revolutions per minute than at 75 revolutions per minute.

The greatest trouble that has been experienced in burning oil in Scotch boilers is the burning of the stay-bolt heads and buckling of the back-connection sheets, due to the flame impinging upon them. This is especially so of short boilers. To avoid this the furnaces are sometimes lengthened by fitting sheet-iron projections lined with firebrick to their front ends.

A burner of the ordinary type, having a small circular discharge orifice, projects the oil through the center of the furnace in a sort of vaporous core composed of minute oil globules, hydrocarbon gas, carbon dust, and carbonic oxide gas, or CO, due to the partial combustion of some of the oil with the air used for atomizing. The core burns from the surface to the center and is surrounded and enclosed by the products of combustion. The air must diffuse itself through the outer gases and penetrate to the center of the core in order to completely consume it. The core, with its surrounding zones, is moving with a certain velocity through the furnace; now, if the core is small in diameter, or the

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furnace long, the air will penetrate to the center of the core and consume it before any of the fuel reaches the back connection. On the other hand, if the core is of large diameter, or the furnace short, the air cannot penetrate to the center of the core in time to prevent some of the fuel from burning on the back-connection sheet. The remedy is to reduce the diameter of the core, or, in other words, to "cut down" or "throttle" the burner until the flame does not reach the back connection. It will then be necessary to put in more burners in order to work the boiler to its capacity. In other words, a short boiler should have three or four small burners in each furnace, while a longer boiler may be fitted with fewer and larger burners.

We have on the Pacific coast three patented burners, the salient feature of which has evidently been overlooked by the patentees, or else is not patentable, for it is common to all three. It consists of a cone or inverted valve placed in the discharge orifice with the apex against the flow of the jet, so that the atomized oil is projected in all directions in a thin sheet, shaped like the surface of a cone, with the apex at the burner. The fuel thus presents a large surface of little thickness to the air, and is quickly consumed, making the desired short flame. If the air could be introduced into the inside of the cone, combustion might proceed even more rapidly.

An engineer of the author's acquaintance, realizing the above principle, carried it out as follows: His burners were of the type known to the oil-burning faculty as retort burners, which means that in the interior are many devious and intricate passages in which the steam and oil act and react upon each other in a complex manner. After the mysterious mixing and retorting the resulting product is discharged from a nozzle which, in the burner under consideration, has a slotted aperture, like an ordinary illuminating gas burner. The burner is placed on the bottom of the furnace and the nozzle turned up with the slot crosswise with the furnace. This causes a thin wall of fuel to be projected right across the furnace, presenting a large surface to the incoming air and allowing none of it to pass the burner without coming in contact with the fuel. The distance from the nozzle to the back-connection sheet is only 8 feet, and, though 350 pounds of oil per hour are burned in each furnace, no trouble has been experienced with stay-bolt heads or back-connection sheets.

There is no reason why heated draft from a Howden or other system cannot be used with oil as with coal, and with good results. But as a smaller surplus of air is required when burning oil, a less percentage of gain would be effected.

Shipbuilding in Great Britain.—The summary of the shipbuilding returns for the United Kingdom for 1902 shows that the output of new launches was much lower than that of the previous year. A total of 823 vessels of 1,451,995 gross tons was launched, as compared with 672 vessels of 1,671,798 gross tons in 1901. It is stated that the outlook for shipbuilding for the present year is not encouraging, as there is absolutely no demand for new ships of the ordinary tramp variety, notwithstanding that builders have reduced their prices materially.

THE VIBRATIONS OF STEAMSHIPS, WITH SPECIAL REFERENCE TO THOSE OF SECOND AND HIGHER PERIOD.—I.*

BY REAR ADMIRAL GEO. W. MELVILLE, ENGINEER-IN-CHIEF, U. S. NAVY.

INTRODUCTION.

At the close of my reply to the discussion of last year on the balancing of engines, I promised to try to clear up the question of the importance of vibrations of periods higher than the first. Indeed, I was much surprised that my paper had failed to be convincing on this crucial point. The whole discussion was left in a very unsatisfactory state. All that I said in my paper was of no value unless these shorter period vibrations were an essentially important feature of the problem, and arose in large part from the unbalanced forces of the engine. Those who differed from me were far from definite in their views. Mr. Taylor,† while advocating almost exclusively the Yarrow-Schlick-Tweedy system, admitted its imperfect balance, and inadequateness if second period moments have to be balanced. And, while his advocacy seemed to imply a perfectly definite belief, in the reply to the discussion he explicitly disclaims having expressed an opinion.

During the last twelve months I have given great attention to the whole subject, and have had the literature on it, both in English and German, thoroughly examined. As a result, I have communicated to *Engineering*, in London, a very long discussion—much too long to be appropriate for a paper before a technical society. Here we need do little more than notice, as concisely as possible, the one point left in dispute from last year.

But there are two minor points which it will clear the ground to touch upon:

VIBRATORY EFFECTS FROM PROPELLER.

1st. The propeller has been made the scapegoat for much which, I think, should properly be charged to the engines. For instance, Mr. Taylor cites three separate ways in which the propeller *may* cause vibration:

(*a*) Due to the water not having a free run to the propeller (which is clearly due to the form of the hull).

(*b*) Due to one or more of the blades being out of true.

(*c*) Due to the propeller being unbalanced.

(*a*) In my paper of last year I referred to Yarrow's experiments which, to him, afforded "overwhelming proof" that the propeller did not affect the vibration of the torpedo boat. But Mr. Taylor points out that the conclusion does not necessarily hold for ships which have not "fine lines, a fine run." True, but the question of hull vibration did not become prominent till we had very full-powered ships, and these, I think, without exception, have fine lines. They are, in a large proportion of cases, twin screws, where the water has the freest access to the propeller. If in Mr. Yarrow's torpedo-boat experiments there was no influence present, it could never be very much in any even moderately fine-lined vessel.

(*b*) With built-up propellers, in cases of any importance, the blades are set carefully to pitch, and still

*Read at the meeting of the Society of Naval Architects and Marine Engineers, New York, November, 1902.

† Mr. Taylor's paper given in MARINE ENGINEERING, January and February, 1902.

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vibration occurs. In solid propellers, suppose that by careless casting the pitches vary for the different blades. Then the forces induced would be almost entirely of first period and consequently concern us little here. But I do not believe the explanation is well founded, for we have the pitches of the various blades of solid propellers measured regularly, and they very rarely reveal important variations. If made of bronze they are corrected.

(*c*) Propellers for high-speed ships are almost invariably balanced (in naval work they are always balanced). But where this obvious precaution is omitted, any degree of unbalance reasonably supposable gives rise only to forces of comparatively small amount. Let us take the case of the *Deutschland*. Her propellers are built up, having four blades, and are 23 feet 3 3-4 inches in diameter. One whole propeller will, therefore, weigh about 27 tons and one blade about 4 1-2 tons. It would be far beyond reasonable supposition to take one blade as 25 per cent. heavy. But this would give about 1 1-8 tons at a radius of about 6 feet, or 2 1-2 tons at crank radius. I find the mass, at crank radius, for cranks II and III to be 32 tons. Hence this extravagant supposition only amounts to leaving about one-fourteenth of one of these cranks unbalanced; or, counting the forces at the propeller twice as favorably placed for producing vibration as at the engine, this fraction becomes one-seventh. Not a very important amount. Let all propellers for high-speed ships be balanced, however.

The effect of the propeller on vibration has unfortunately been the subject of much mere speculation, when a few simple measurements would have convicted it or acquitted it of the crimes with which it is charged. The only point which seems to be fairly established is that it is frequently the cause of horizontal vibrations, occasionally severe; for these are usually of third or fourth period, according as the propeller has three or four blades. Occasionally the double period has been noticed. Also the jarring of the shaft in the stern bearing may be, to some extent, referred to the propeller, but this action takes place more intensely when the engine is vibrating the ship severely.

May we not, then, dismiss the propeller as being a factor of small importance with engines at any usual speed of revolution?

POSSIBLE HIGH FREQUENCY OF VIBRATIONS.

2d. In section 3 of his paper Mr. Taylor says, "There is probably a limit to the frequency with which actual ships can vibrate, but there is little positively known on this point." I know of no physical cause limiting the speed of vibration. I need only refer again to the quotation I made, in my reply to the discussion, from Mallock's observations, where he noted vibrations as high as 1,950 per minute. Any one who has been in the hold of a ship that was being riveted up receives peremptory proof from the deafening noise of all pitches that there are modes of vibrations of the structure for which the frequency ranges up to many thousands per minute.

I will now deal very briefly with three vital questions:

1st. Do important vibrations of second and higher period occur?

2d. Are the unbalanced forces of higher period in the four-crank engine important?

3d. Are the forces of higher period sufficient to account for the vibrations of corresponding period?

Do Important Vibrations of Second and Higher Period Occur?

RECENT INVESTIGATIONS.

This seemed to be a subject of great doubt in the discussion of last year. Happily it is now possible to prove, not only their occurrence, but great importance, by reference to careful observation.

Since 1893 the German Navy Department has regularly undertaken the measurement of vibrations in all new warships, by means of Schlick's pallograph. An account of some of these investigations and a large number of pallograms will be found in a paper by G. Berling, Imperial Naval Constructor, published in the *Jahrbuch der Schiffbautechnischen Gesellschaft*, vol. ii., 1901, p. 373—"Comparative measurements of ship vibrations on the *Hansa* and *Vineta*, cruisers of the German navy." Berling's investigation dealt largely with a comparison of the action of the Schlick engine and the ordinary four-crank engine. It is, therefore, of special interest for us here in view of last year's discussion.

A pallogram is a line drawn by the pallograph on a strip of paper moving uniformly with the time. It records at each instant, very closely, the displacement, due to vibration, of the part of the ship at which the instrument is placed. It is thus a record, on a time base, of the vibratory movement of one particular part of the ship. When the pallograph is properly placed, one pencil records the vertical transverse vibrations, and one the horizontal; while a third pencil marks seconds.

SYNTHESIS AND INTERPRETATION OF A PALLOGRAM.

Let us first build up a few pallograms. We shall then be able to interpret clearly those drawn by the vibrating ships and appreciate the strong and definite evidence they bear. We shall also be led to assign a meaning to the term "Vibrations of Equal Importance" when dealing with more than one period.

Fig. 1 is a pure sine curve, and represents a vibration of a single period. Suppose it has one inch total travel occurring 100 times per minute. This we will take as our unit vibration, in which $S = 1$ and $n = 100$, S and n denoting the travel and frequency. If a body, of mass m, is submitted to this vibration it can at once be determined that the maximum inertia force, at each end of the travel, will be—

$F = .142m$, and for a vibration occurring n times per minute, and having travel S,

$$\frac{F}{m} = 1.42 \times 10^{-6} \times n^2 S.$$

F being in pounds weight if m is in pounds.

That is, a person weighing 160 pounds standing on a deck vibrating vertically thus would experience a variation of pressure on the soles of his feet, above and below his weight, of 22.7 pounds, $160 - 22.7 = 137.3$ pounds when at the highest point of vibration, and $160 + 22.7 = 182.7$ pounds at the lowest. This would be quite an important vibration. To the vibration of Fig. 1 add one of 200 per minute, $n = 200$. Take $S = 1$-2 inch and make both vibrations come to upward

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maximum displacement at the same time. Fig. 2 shows the vibrations separately, and Fig. 3 the combined vibrations.

Note that in Fig. 3 the value of S for first period is given by the vertical distance between the two maxima C and D, not by the total travel.

In Fig. 4. for the second period vibration, $S = 1\text{-}4$ inch.

In Fig. 5, for the second period vibration, $S = 1\text{-}8$ inch.

In Fig. 4 the maximum forces for first and second period vibrations are equal, but the latter is applied twice as often as the former, and on that account could not fail to be much more annoying.

I take, all through this paper, as a measure of the importance of a vibration the value of

Force × frequency,

and in my paper for *Engineering* I give reasons which, I believe, show it to be a fairly satisfactory measure. Therefore, in Figs. 3, 4, and 5 the relative importance of the second period vibrations compared with those of first period are 4, 2, and 1, respectively, as noted on the figures. If, now, to Fig. 4 we add a fourth period vibration of one-sixteenth of an inch, starting with a maximum upward displacement, we get Fig. 6. Comparing it with Fig. 4, the crests are just a little sharper and the hollows slightly notched upward at the bottom.

Figs. 7 and 8 are derived from Fig. 2 by shifting the second period curve to the right by one-eighth and one-fourth of its period, respectively. In both these cases the downward movement differs from the upward. In Fig. 9 we have first and third period combined, and this gives us a pallogram symmetrical about the base line. An infinite variety of pallograms could be produced, but these will serve our purpose.

What do these illustrations teach? Unless force × frequency for short period vibration is relatively very large, as in Figs. 3, 6, and 8, the number of crests will correspond to the fundamental vibration. In Fig. 9, where the ratio of force × frequency is 3, the short period cannot nearly produce crests, only sharpening those of the fundamental vibration. If the pallogram departs sensibly from a sine curve, short period vibrations are prominently present. For instance, if Fig. 5 were drawn to the size of any of the pallograms given below, its departure from a true sine curve would not be observable. Yet here the second period vibration is as important as the first, and to any one on deck the difference of bodily sensation would be very marked.

If the relation of epochs or phases changes, the shape of the resultant curve undergoes a marked change, as is seen by comparing Figs. 3, 7, and 8. And a marked change will often follow from a temporary change in the magnitude of one of the component vibrations.

We have usually, then, to depend on two features for evidence of short period vibrations:

1st. Departure from a true sine curve.

2d. Progressive change of shape.

BERLING'S PALLOGRAMS AND WHAT THEY TEACH.

Let us now examine a few of Berling's many admirable pallograms.* Figs. 10 and 11 are from the *Kaiserin Augusta*, a three-screw ship, with three cylinder engines having cranks at 120 degrees. Fig. 10 is with three screws at 102 revolutions, the pallogram being taken on the upper deck at frame 103. The upper line in all pallograms gives the vertical vibrations of the instrument, the lower line the horizontal vibrations, and the middle line marks seconds. At every five seconds there is a longer downward stroke.

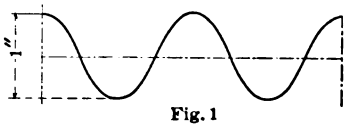

Fig. 1

$s = 1$ inch
$n = 100$ per minute
$\frac{F}{m} = .142$

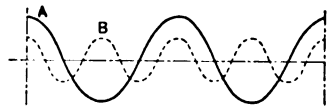

Fig. 2

	1st period.	2nd period
s	1	.5
n	100	200
$\frac{F}{m}$	.142	.284

A=1st period. B=2nd period

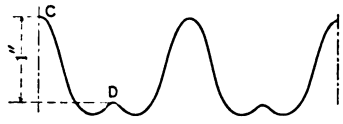

Fig. 3 *Marine Engineering*

	1st period.	2nd period
s	1	.5
n	100	200
$\frac{F}{m}$	.142	.284

Force x frequency 1 to 4

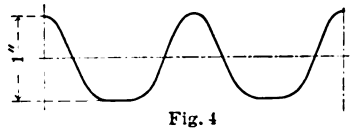

Fig. 4

Period	1st	2nd
s =	1	.25
n =	100	200
$\frac{F}{m}$ =	.142	.142

Force x frequency 1 to 2

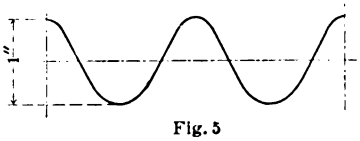

Fig. 5

Period	1st	2nd
s =	1	.125
n =	100	200
$\frac{F}{m}$ =	.142	.071

Force x frequency 1 to 1

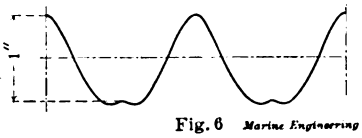

Fig. 6 *Marine Engineering*

Period	1st	2nd	4th
s =	1	.25	.0625
n =	100	200	400
$\frac{F}{m}$ =	.142	.142	.142

Force x frequency 1 2 4

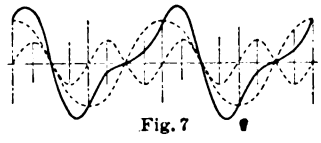

Fig. 7

Period	1st	2nd
s =	1	.5
n =	100	200
$\frac{F}{m}$ =	.142	.284

Force x frequency 1 to 4

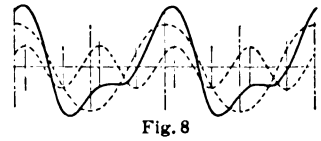

Fig. 8

Period	1st	2nd
s =	1	.5
n =	100	200
$\frac{F}{m}$ =	.142	.284

Force x frequency 1 to 4

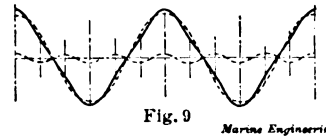

Fig. 9 *Marine Engineering*

Period	1st	3rd
s =	1	.111
n =	100	300
$\frac{F}{m}$ =	.142	.142

Force x frequency 1 to 3

*Berling, in his paper, gives a careful account of the comparative measurements already referred to, which were carried out under his superintendence. Further discussion of the results and much additional information regarding the ships is found in the papers of von Jaski and Mohr, *Schiffbau*, 1900 and 1901.

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Most of the vertical vibration is a fairly pure sine curve, though at some parts the crests are much more rounded than the hollows, indicating a considerable second period vibration. Here, as in most of the pallograms, one would at first sight, from counting the crests, be apt to assert the presence of first period vibration only, but we have seen above that more careful thought will interpret the diagram differently. The maximum vibration is 16 millimeters, or .63 inch.

Taking the value of force × frequency in Fig. 1 as unity, and calling its value for any other vibration V, we get

$$V = \frac{n^2 s \times n}{100^2 \times 1 \times 100} = \frac{n^3 s}{10^6}. \qquad (1)$$

or, if s is given in millimeters,

$$V = \frac{n^3 s}{25.4 \times 10^6}. \qquad (2)$$

Similarly, the ratio of the maximum forces or accelerations is

$$A = \frac{n^2 s}{100^2 \times 1} = \frac{n^2 s}{10^4}. \qquad (3)$$

or, with s in millimeters,

$$A = \frac{n^2 s}{25.4 \times 10^4}. \qquad (4)$$

Hence, in Fig. 10, we have

$$V = \frac{102^3 \times 16}{10^6 \times 25.4} = .67. \quad A = \frac{.67}{1.02} = .66.$$

The change in amplitude during the observation is probably due to the three engines not running at precisely the same speed, possibly to a slight change of speed in all. The horizontal vibration is of third period, and, no doubt, arises from the three-bladed propellers. I will not notice these horizontal vibrations further in this paper .

Fig. 11 was obtained from two screws, at the upper deck, frame 1, 105 revolutions. The vertical vibration here is a beautiful example of the simultaneous existence of first and second period vibrations, the latter being much the more important, as is shown by comparison with Figs. 3. 7, and 8. All these figures are closely imitated at the different parts of the pallogram. showing that during the observation there were changes of the phase relationship of the two sets of vibrations, as explained above. This change was very probably due to a slight change in the speed of revolution during the minute and a half of observation; thus producing at one time a more near approach, at another a less near approach to synchronism, .in both of the vibrations. the change toward or from synchronism being naturally different for the two periods. As is well known, a change toward perfect synchronism produces not only an increase of amplitude, but a change of the epoch of the response relative to the epoch of the exciting force or moment. Slight difference of speeds of the two engines may also have had something to do with the result.

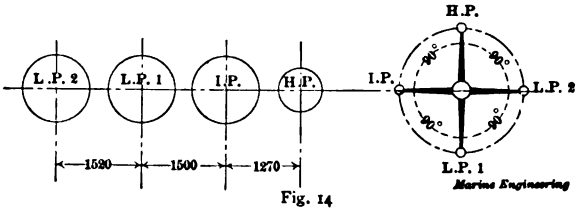

Fig. 14

By comparing with Fig. 3 we see the value of s for first period, at the beginning of Fig. 11, is not 5.5 millimeters, but must be measured from the lowest point up to the bottom of the little notch at the top. Say s = about 4.5 millimeters. Then

$$V = \frac{105^3 \times 4.5}{10^6 \times 25.4} = .21 \quad A = \frac{.21}{1.05} = 20.$$

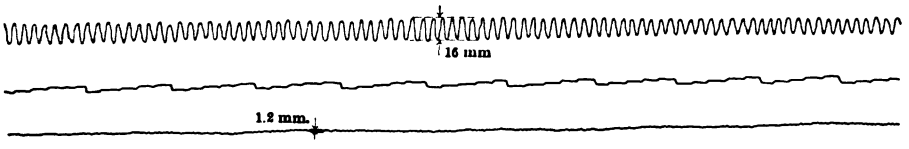

Fig. 10 S.M.S. KAISERIN AUGUSTA. 3 SCREWS, 102 REV'S, UPPER DECK, FRAME 103.

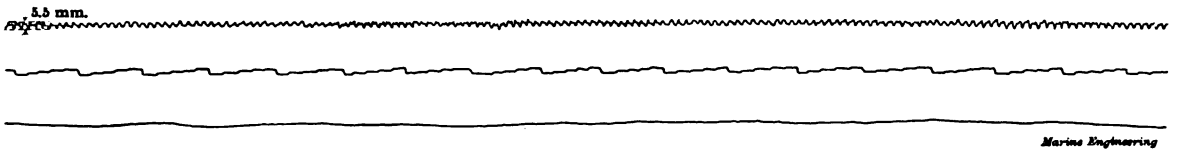

Fig. 11 S.M.S. KAISERIN AUGUSTA. 2 SCREWS, 105 REV'S, UPPER DECK, FRAME 1.

The comparison with Fig. 3 also shows that at this point the second period vibration must have had a value of V considerably over four times that just given for the first period, say, at least,

$$V = .21 \times 5 = 1.05.$$

In the *Kaiserin Augusta*, then, the second period vibration is much more severe than that of first period, though the forces and moments which produce the former are much the smaller. I will return to the point toward the end of this paper, and show that this is exactly what might be expected.

Figs. 12 and 13 are pallograms from the *Vineta* and *Hansa*, respectively. The *Hertha, Hansa,* and *Vineta* are sister ships (Berling, page 374), the *Hertha* and *Hansa* having Schlick engines and the *Vineta* four-

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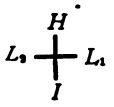
crank engines arranged, according to Berling, as in Fig. 14; though the more recent papers of von Jaski and Inch* give the ordinary arrangement of contiguous cranks opposite



If Berling is correct, the opposite cranks of the *Vineta* not being contiguous, a more than usually strong first period couple will be produced, while that of second period will be less than usual. Pallograms reproduced are the worst given by Berling in each case, and he mentions from 120 to 140 revolutions as those giving greatest vibration. A considerable part of the upper curve of Fig. 12 shows a fairly pure sine curve; though other parts, as we would expect, indicate pronounced second period vibrations. Berling, however, speaks only of experiencing first period vibration, and does not mention any other.

Fig. 13 shows principally second and still higher period vibrations, as we expect from the Schlick engine. However, at several places, notably about five seconds from the beginning of the observation, first period is also present, possibly due to want of perfect rigidity in the engine seat. Close examination of this pallogram shows, inverted, the sharp crests and well-rounded hollows even more marked than in Fig. 4, indicating the presence of, relatively, very strong fourth and higher period vibrations.

The relative values of the vibrations are:

	S.	Rev.	*n.*	*V.*	*A.*	Period.
Vineta..	4.7	137	137	.48	.35	1st.
Hansa.....	3.5	140	280	3.02	1.08	2d.

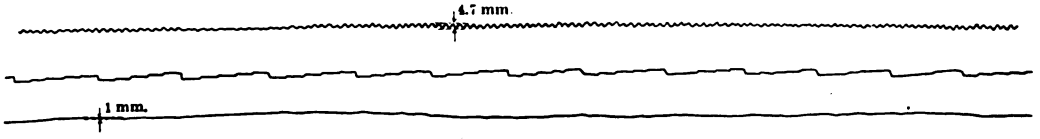


Fig.12 S.M.S. VINETA, 3 SCREWS: 136-137 REV'S, BETWEEN DECKS, FRAME 2.

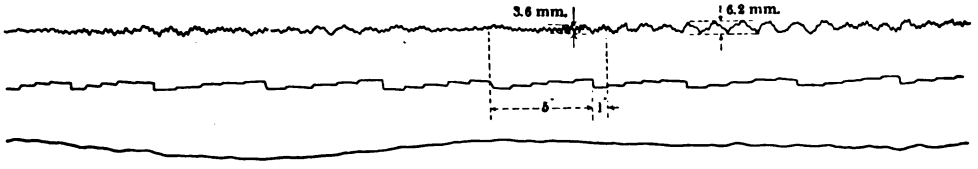


Fig.13 S.M.S. HANSA, 140 REV'S, UPPER DECK, FRAME 7

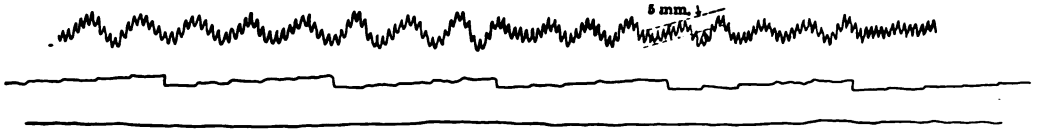


Fig.15 S.M.S. TORPEDO BOAT S.42 235 REVS.

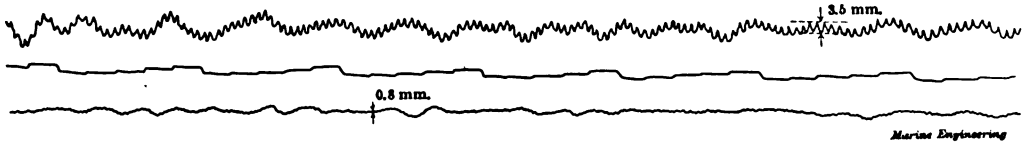


Fig.16 S.M.S. TORPEDO BOAT S.42 250 REVS.

Thus V is over six times and A three times as large in the ship with the "balanced" engine, and this takes no account of the still stronger fourth period vibration of the Hansa!

Figs. 15 and 16 are from torpedo boat *S. 42* of the German navy, when it had Schlick engines. Fig. 15 is difficult to understand, as it seems to indicate 310 or 320 revolutions rather than 235, as marked. Hence, I pass it over, though it shows a severer vibration than any other pallogram given by Berling for this ship.

The next in magnitude I give in Fig. 16. Here we

*American Society of Naval Engineers, vol. xiv., pp. 22, 33, 213.

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have the well-marked divergence from a sine curve shown by the sharp crests and well-rounded hollows as in Fig. 4. Thus we have, more marked than in the *Hansa*, first period vibrations. But the shape of the curve indicates much more severe vibrations of second period; and, consequently, it is not surprising that Berling, and also Mohr in his paper,* both speak of the second and not of the first period.

For first period we have—

$$V = \frac{250^2 \times 3.5}{25.4 \times 10^6} = 2.15 \qquad A = \frac{2.15}{2.5} = .86.$$

The value of V for second period it is impossible to assign, but comparison with Fig. 4 indicates that it is more than twice as large as the value just given.

Torpedo-boat *S. 42* had first a three-crank (unbalanced) engine, the cranks being at 120 degrees. This, for reasons not explained, was replaced by a four-crank (unbalanced) engine with cranks at right angles, which seems to have produced severe vibration, as it was rebuilt and "balanced" from data by Schlick. We are further informed by von Jaski† that " the engine was so faulty that the boat with the Schlick engine could not be used in squadron evolutions, and had once more to get a shaft with cranks at right angles. Furthermore, the end sought—to reduce the vibrations of the hull by counterbalancing the free vertical forces and the rocking moments—was not obtained; on the contrary the vibrations were very much greater."

Mohr's statement (which occurs in his paper on the balanced and unbalanced engines of torpedo boat *S. 42*) is to the same effect. The evidence from this experiment is most conclusive.

Berling ingeniously explains these second period vibrations by the action of the propeller; apparently not noticing the strong second period moment of the Schlick engine. I have dealt fully with the question in my paper written for *Engineering*, and I think I have conclusively demonstrated that the propeller would not produce the effects attributed to it, while the forces of the engine afford ample explanation. These second period vibrations were found in all cases with Schlick engines, as the following quotation from Berling (p. 389) shows:

"This fact (second period vibration) does not stand isolated, but is confirmed by other sister ships of the investigated class, the cruisers *Hertha* and *Victoria Luise* and torpedo boat *S. 42*, which ships are all fitted with Schlick engines."

It could hardly be otherwise. Mohr is perfectly clear with regard to second period vibrations, as a few quotations will show. The first I give begins with a comparison of the first and second period forces and moments for *Vineta, Hertha,* and *Victoria Luise*.‡ As the comparison is made at the same value of $\omega^2 R$, the values for the *Hertha* would have to be reduced one-sixteenth to make it for the same piston speed, as her stroke is 800 millimeters, while that of the other two is 750 millimeters.

[Mohr, p. 283.]

	1st Order.		2d Order.	
	Free Force. kg.	Free Moment. mkg.	Free Force. kg.	Free Moment. mkg.
Vineta.....	2495	27200	677	18420
Hertha.....	Vanishing.	Vanishing.	4750	35950
Victoria Luise	Vanishing.	Vanishing.	5420	30000

"From the enormous magnitude of the forces and moments of the second order in balanced engines it may be clearly seen that they are the principal cause of the observed *'Vibrations of a double period.'* Perhaps their action is still further increased by the variable propeller thrust. *The free force of 2,495 kilogrammes and the free moment of 27,200 millikilogrammes in the engine of the Vineta are indeed removed by the Schlick method of balancing in the other two engines; but in their stead the forces of the second order,* THAT OCCUR TWICE AS FREQUENTLY,§ *are considerably larger, even still larger than the forces and moments of the first order that were to be removed.* This faulty balancing of the forces of the second order is probably also the cause of the considerable vibrations of our large ocean liners, that are provided with 'balanced' engines. More than by the exact comparison of the two engines of *S. 42*, has this superficial comparison of the large engines of our cruisers proven that a balancing of a four-crank engine without regard to the finite length of the connecting rod, *i.e.*, without regard to the inertia forces of the double period, is, indeed, no balancing at all; that, on the contrary, it is absolutely necessary to consider the forces of the second order more or less, as the circumstances may demand."

This is precisely the ground I stand on. It is the ground my friend Macalpine took many years ago and is one of the essentials on which his system is founded.

(To be continued.)

Shipyard Failures.—The Moss Iron Works and Dry-Dock Company, Brooklyn, N. Y., has found it necessary to ask for an extension of time on $450,000 worth of commercial paper. The statement given out to the public is that owing to heavy government contracts on which the money is paid slowly, the company is temporarily embarrassed.

The William R. Trigg Company, shipbuilders, Richmond, Va., applied for a receiver the latter part of December. It is understood that the company has lost money on government and private contracts.

*Comparison between the balanced and unbalanced engines of torpedo-boat *S. 42*, by Hans Mohr, *Schiffbau* II, January 8, 1901, p. 237.

†Results of Investigations of Recent Engines of the German Navy, by Chief Constructor Köhn von Jaski, *Schiffbau*, June 8, 1900, p. 507; Translation, *Journal American Society Naval Engineers*, vol. xiv., p. 18.

‡ Mohr's figures, as given in the table immediately following, make the case stronger than I would have expected, but it is impossible to check them for want of sufficient data, and the doubt as to the crank sequence of the *Vineta*. He says, regarding his calculations: "As a comparison, only, is under consideration in this case, the vertically vibrating and rotating masses are not separated. . . ." Surely he has not included the rotating masses in making his calculations for second period!

The matter is of little importance here, as his conclusions are amply justified by the figures for the *Deutschland*, but I have given his figures to make the rest of the quotation intelligible.

§The emphasis is Mohr's.

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GAS ENGINES AND THEIR TROUBLES.—VIII.

BY E. W. ROBERTS.

Preparing for a Cruise.

When starting upon a long trip with a motor boat it is the wisest plan to anticipate any trouble that would be likely to arise by being prepared with tools and extra parts to cope with any emergency. It is assumed, of course, that the operator has had previous experience and that he will not undertake an extended journey without at least having become somewhat familiar with the operation of his boat in his home waters. In selecting the supplies and tools that you are likely to need, do not scorn any possible necessity by assuring yourself that there is a very small chance of any certain part being broken. Remember that it is the expected that often happens the least. What we are not looking for is generally what we have to contend with.

Take the following example: I once sold a boat, as agent, to a college professor for his explorations in search of fossil shells. As much of his work was in shallow waters, he was compelled to get a stern-wheeler. This boat was so constructed that the power was taken from the engine to the wheel by a chain running free and unguarded over the water for about three feet. I suggested placing a trough under this chain, so that it would not go overboard if it broke. But I was promptly informed that the chain was the very last thing that would break and that he would take the chances at any rate. Poor, deluded professor! that chain broke in less than two weeks and when he was in the middle of a lake a mile wide. Sure enough, it went overboard as I had prophesied, and it took nearly a week to get a new chain. The next chain had a trough put under it.

SPARE PARTS.

In the matter of extra parts that should be taken on a trip, it is hard to give a definite list, as the construction of engines varies so much. It might be said in general, however, that the igniter, having the smallest and most delicate parts, is the most likely to become deranged. It is an excellent plan to take at least one full set of igniter parts, and if the engine has more than two cylinders, or if the trip is to be a long one, two complete sets of repairs should be carried with you. The moving parts are those most likely to break or get out of order. Springs quite often become weak or break, and especially, should flat springs be used, a full set should be in the repair kit. Always make sure to have extra insulation and any such little items as screws, washers, nuts, and cotter pins. Wire for carrying current is often broken and a new wire will generally make a more satisfactory repair than a spliced one, so that it is quite handy to have plenty of wire. The best wire for igniter purposes is No. 14 stranded conductor. In case ignition is by jump spark, a full set of plugs should be carried for a tour of any extent, as should springs and all parts of the circuit breaker.

DYNAMO AND BATTERY.

The dynamo and the battery require their modicum of attention and for them the supplies should be carefully considered. For the dynamo or magneto there should be extra brushes and brush springs, and for a long trip perhaps an extra commutator. For the battery there should be a complete set of spares, if of the wet type, or a complete set of new cells if a dry battery is employed. The plan of having a spare battery already connected up, as explained in Chapter VI, is a good one, but extras should be carried in addition to the spare battery.

The vaporizer is of such varied construction that it is difficult to point out what supplies it would require. For those with valves, new valves should be carried, since the seats wear out and the prongs that guide the valve break off. Those of the float-feed variety, with atomizer or nozzle, seldom have moving parts, and only the delicate pieces which are so exposed as to be easily broken require replacing. The needle valve which controls the gasoline is probably the part that will be broken or bent more than any other, and an extra one might be found convenient.

ENGINE SUPPLIES.

Supplies for the engine proper which it would be wise to carry are extra valve springs for a four-cycle engine, and possibly an extra valve. The connecting rod is not a part that will give out very often, but occasionally one will break owing to a flaw or neglect to take up lost motion, and then you are in a peck of trouble. Thin sheet asbestos for packing should always be on board a gasoline launch. It should be of good quality and thin, not over 1-32 inch thick. Thicker packing will answer in a pinch, but is not apt to hold so well. A four-ounce bottle of orange shellac dissolved in grain alcohol, and a half-inch brush, will be found convenient. It is to be used for coating the surface of a joint before putting on the asbestos packing. Don't use white shellac or shellac that has been dissolved in wood alcohol. A small piece of common brown soap will be found handy for lubricating the joints of the gasoline connections if they have to be taken apart. Should you have no soap, shellac will answer, although it makes the joint a little harder to unscrew. Always keep some lamp wicking for packing the stem of the needle valve. This wicking should always be moistened with soap and never with oil. Another important item of supplies is an assortment of nuts, bolts, cap screws, and machine screws of the various kinds used on the engine.

The reversing mechanism and any other mechanical adjuncts, such as an air pump for the starting tank, should not be overlooked. Perhaps the novice will be surprised to find that I recommend the carrying of a spare propeller. However, the gasoline boat is one that is frequently knocking about along unfamiliar shores where a hidden spile is apt to relieve the propeller of a fluke or two. Twice in two weeks I started out with a four-bladed propeller and returned with a two-bladed screw. The second time it happened I decided to use a two-bladed propeller, with no perceptible change in the performance of the boat except that it was a little bit sluggish about getting under way.

TOOL KIT.

For the tool box the following is a good equipment: A twelve-inch monkey wrench or automobile wrench, a bicycle wrench, a ten-inch Stillson pipe wrench, a pair of gas pliers, a 1 1-4-pound machinist's hammer, a ten-inch machine screwdriver, a four-inch machine screwdriver, a hatchet, an assortment of nails, and a

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coil of electric tape. Besides the above necessary equipment, you may find it convenient to have a brace with a few bits, and a twist drill or so for drilling out broken bolts or set screws. Two oil cans, one with a long spout and another with a short spout, and possibly a force-feed oiler for getting into tight corners, should be part of the kit. Two or three good cold chisels and several files, including a round, a half-round, and a coarse flat file, should form a part of the equipment.

BOAT EQUIPMENT AND SUNDRIES.

Then there are a few other articles, not strictly allied to the mechanical equipment, which my experience as a launch owner has proven to be desirable. One of these is a pike pole. An idiot of a steersman once ran me deliberately into a sandbar in a narrow inlet within twenty feet of a charge of dynamite on which the fuse had already been lighted. Of course I didn't have a pole, and pulled off my shoes and rolled up my trousers in something like fifteen seconds. I got around the bend just as the dynamite let go. I had a similar experience, with the dynamite omitted, on the Maumee river with a non-reversible engine. We had no pole, but fortunately there were no ladies along, so one of the boys stripped and went in.

Another handy tool for shallow waters is a sharp-bladed hook for cutting eel grass off the propeller. When the direction of the propeller's rotation may be reversed, the grass may often be thrown off by running the wheel back and forward, but with the reversing propeller it is not so easy. If the boat has a long fantail and considerable freeboard, there is no fun in hanging over the stern and pulling the grass off with your hands, and still less in stripping off your clothes and diving for it.

Something to carry gasoline in, such as a five-gallon can, will be found handy in country districts. A funnel is not absolutely necessary, but will often save spilling the gasoline when filling the tank. Should you use a belt-driven dynamo you should have some No. 22 copper wire for sewing the belt and an extra piece of belting. I have found a speed indicator convenient at times for testing the speed of the engine, to see if it was working at its best.

Always make sure before starting out that your supplies are ample. Neglect of this precaution is often the cause of much inconvenience. Make it a point to go over them carefully, and see to it that you have plenty of gasoline, gas-engine oil, and cup grease. Should you at any time get out of any of these supplies, you may run your engine on kerosene, if it is already warm and you can put up with a little smoke. Vaseline may be substituted for cup grease, but nothing but the lightest of cylinder oils should be used for the engine.

When you are satisfied that you are well supplied with everything you need, make certain that the engine is in good running order. Go over every part from the propeller to the flywheel and don't neglect a nut or a screw. Above all things see that your connecting rods are well adjusted and that the bolts are tightened up snugly. If the engine is not clean, wipe it up, and look to the cylinder and the exhaust passages that they are not sooted up. See that your oil cups feed freely and that there is the proper height of oil in the crank case. Screw up the gland on the propeller-shaft stuffing box, and, if it is nearly up to the end of the threads on the nuts, repack it.

The igniter system should have the most careful attention. The battery should be tested to see if it is weak, and the wire should be tested for both open and closed circuits, and every binding-post screw tightened up. Then test the springs, and if there is an adjustment needed do not neglect to make it.

Finally, should anything have been overlooked in the above summary, do not think you will not need it, if you have found it useful before. The prime object to be kept in view in a preparation of this kind is so to make ready that you may proceed with your trip as independent of outside help or repairs as possible.

(To be continued.)

Safety-Valve Springs.

BY H. K. SPENCER, U. S. R. C. S.

As springs are always used for loading the safety valves of marine boilers, it is well to consider how such springs are proportioned.

The duty safety-valve springs must perform is that, first, they are compressed an amount sufficient to resist the working load on the valve, and then must be able to withstand a still further compression equal to one-eighth the diameter of the valve opening.

A load applied to a helical spring puts the material under a torsional stress. The formulæ given below are derived from the simple torsion formulæ giving the strength and stiffness of members under torsional stress, and those for square steel are modified, as they should be, by the results obtained by St. Venant from his investigations as to the comparative stiffness of round and square shafting. The constants employed were obtained experimentally. The springs tested were such as are commonly used in shaft governors, and were not so carefully made and tempered as are safety-valve springs, so the figure given for the elastic limit is possibly a little low for carefully-tempered spring steel. Within the elastic limit of the material, for each increment of load the increment of extension or compression was found to be quite uniform—*i. e.*, if a load of 100 pounds extends or compresses the spring 0.1 inch, a load of 200 pounds will extend or compress it 0.2 inch: a load of 300 pounds, 0.3 inch, and so on, each additional 100 pounds increasing the extension or compression by 0.1 inch until the elastic limit is reached.

The formulæ are given for both round and square steel, although square steel is almost always used for safety-valve springs. The notation is:

r = mean radius of coil of spring in inches.
d = diameter of wire in coil in inches.
n = number of turns in coil.
P = load on spring in pounds.
P_1 = safe loads in pounds.
E_s = modulus of elasticity for shearing = 11,000,000.
S_e = elastic limit for shearing = 85,000 pounds per square inch.
S_1 = safe shearing load in pounds per square inch.
D = deflection of spring in inches.
D_1 = safe deflection in inches.

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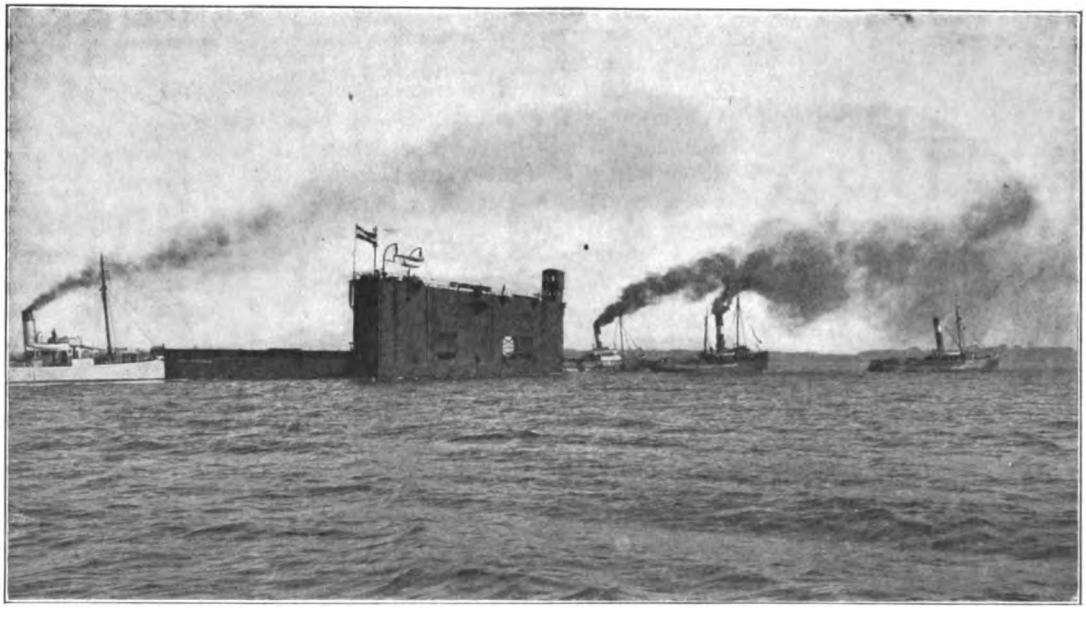
The formulæ are for—

Round Steel	*Square Steel*
1. $P = \frac{.196\, S_1 d^3}{r}$	4. $P = \frac{.2 S_1 d^3}{r}$
2. $D = \frac{64\, P r^3 n}{d^4 E_s}$	5. $D = \frac{44.83\, P r^3 n}{d^4 E_s}$
3. $D_1 = \frac{12.56\, S_1 r^3 n}{E_s d}$	6. $D_1 = \frac{8.96\, S_1 r^3 n}{E_s d}$

To show the application of the above formulæ, consider a 3-inch safety valve loaded for a pressure of 160 pounds. The working load on the spring is 1,130 pounds, for which load the spring should be so proportioned that the stress to which the material is subjected is well within the elastic limit, about one-half that amount. The ratio of diameter of wire to mean diameter of coil is, ordinarily, 1 to 5. Calling $S_1 = 45{,}000$, and substituting in equation 4, gives $d = .56$ inch. The spring should have such a number of turns that the compression to give the working load will not be inconveniently great—say about one inch—and that the additional stress put upon the material by raising the valve with the hand gear will not exceed the elastic limit. Determining the number of turns in the coil from equation 5, with D taken as 1 inch, and d as .56 inch, n is found to be 7.78. The maximum deflection of the spring is to be 1 inch plus one-eighth the diameter of the valve—in this case 1 3-8 inches—which, substituted in equation 6, gives $S = 60{,}300$ pounds per square inch, a stress well within the elastic limit, and as such a stress is only occasionally applied it is perfectly safe.

When the valve rises it presents an increased surface to the steam pressure, a circle whose diameter is that of the valve plus twice the breadth of seat, or, with conical seats, twice the projected breadth of face. Assume that the projected breadth is 1-8 inch, then the area under pressure is that of a circle whose diameter is 3 1-4 inches, which would increase the area 1.23 square inches, and the load on the spring would then be 1,130 lbs. + (1.25 × 160) = 1,330 lbs. Then, from equation 5, $D = 1{,}206$, which means that the valve should open .206 inch with a pressure just exceeding 160 pounds; and probably it does when it first rises, but the tendency of the spring to reclose the valve sets up a vibration which continues until, when under a reduced pressure, the valve touches the seat; then it remains seated until the pressure is again sufficiently high to raise the valve. The tendency to increased lift, as the result of the greater surface presented by the opened valve, can be still further increased by turning a lip on the edge of the valve beyond the face and giving the escaping jet a downward direction. The tendency to increased lift when discharging can be defeated, to an extent, by employing too stiff a spring.



TOWING ONE SECTION OF HAMBURG FLOATING DOCK FROM FLENSBURG, GERMANY.

Hamburg Floating Dry-Dock.

In January of last year the Reiherstieg Schiffswerfte und Maschinenfabrik, Hamburg, entrusted to the Flensburger Schiffsbau Gesellschaft, Flensburg, Germany, the building of a large "offshore" floating dock, to the designs of Messrs. Clark and Standfield, of Westminster. The first plate was laid on the keel blocks on the 15th of March, and by the launch of the second half on the 1st of October the dock was practically completed. It consists of two equal sections securely bolted together, having a total length of 507 feet 9 1-2 inches. The breadth is 100 feet 1-2 inch, and the height 41 feet 1-2 inch. With these dimensions a vessel of 11,000 tons dead weight can be lifted; the proposed time for doing this is estimated at about 1 1-2 hours.

The outfit is very complete, comprising all the latest designed improvements for efficient and rapid docking. Besides mechanical bilge and side shores, there are two hydraulic side shores for centering the vessel on the keel blocks. The dock is provided with eight engines, direct coupled by means of rods to an 18-inch centrifugal pumping installation consisting of eight Gwynne pumps. From the main drain, also 18 inches in diame-

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ter, there are 32 branches leading to all compartments. Each valve of the pumping compartments is fitted with its own hydraulic press, but certain presses are grouped together and worked by a single lever in the valve house, which is situated on top of the wall. Hydraulic pressure is generated by two accumulators placed upon the respective halves of the dock, whilst steam for the engines is obtained from the shore.

A Worthington pump provides a washing-down service for washing down vessels, as well as filling up their tanks, and a steam service is fitted throughout to protect the inlet and outlet pipes, valves, bilge shores, etc., against frost, and also for heating purposes. Valve indicators, connected to each distributing valve, are fitted in the high wall, and pneumatic water-level indicators for each compartment are placed in the valve house, where they are at all times in full view of the engineer.

The launch of this dock commenced a new era in the history of the Flensburg yard, as it was the first to take place from the commodious new premises opened by the company, where there are five large berths capable of taking vessels of the largest size. The two halves of the dock, which were built side by side, occupied four of these berths. They were towed separately round the Skaw by three strong tugs and arrived in Hamburg after a six days' passage.

MARINE ENGINEERING DESIGN—THE PIPE ARRANGEMENT.

BY J. CALDER.

To the young marine engineer the complicated drawing known as the *pipe plan* and consisting of many superposed lines is not of much educational value. The trees cannot be seen for the forest, and a diagrammatic view with conventional markings will be found more instructive.

On the inset for this month are given the water and steam connections for the triple expansion engine and auxiliary machinery of a modern freight steamer of 1,500 I.H.P. and 10-knot speed. Below in tabular form are the dimensions of the connected apparatus and sizes and service of the various branches for piping. The diagrams are self-explanatory and should be followed in detail, system by system, but the student should bring to their study and analysis a comprehensive idea of the ends to be attained. These are as follows:

Viewed as a heat engine, converting heat into work by the multiple expansion of the working fluid in stages, the primary function of the piping is to convey to the engine a continuous supply of working fluid at a high temperature; to collect in a suitable form by condensation, and in a state free from air or impurities, as much as possible of the expanded fluid, and to complete the cycle of operations by restoring the latter

DIMENSIONS OF PIPES, ETC., IN INCHES.		STEAM EXH.						SUCTION.											DISCHARGE.														
MACHINERY PARTICULARS.		175	120	30	Cond.	Atmos.	F. W. Htr.	M. Boiler.	Aux. Boiler.	Cond.	Sea.	E. R. Bilge.	Bilge Sys.	Ball Sys.	Feed Tank.	F. W. Tank.	Hot Well.	Oil Main.	M. Feed.	Aux. Feed.	M. Bol's.	Aux. Bol's.	Fire Main.	San't. Sys.	Eng. W. Serv.	Cond.	Evap.	Over Board.	Ball Sys.	Feed Tank.	Ash Eject.	Serv. Blow.	Bot. Blow.	F. W. Heater.	Shaft W. S.	Oil Main.
SPACE, ENG. RM. 25′ 7″. BOILER RM. 23′ 0″.																																				
2	M. Boilers, 14 ft. 0 in. × 12 ft 2 in. × 175 lbs.	5½				7½																									1½	2½				
1	Aux. Boiler, Vertical, 100 lbs.	4				4½																									1½	2				
1	Main Eng's $\frac{22 \times 36 \times 59}{42}$	6½			17																															
1	Condenser, 2630 sq ft										1½					1½																				
1	Attached Aux. Pump, 24½ × 18									5½ × 25																	9		5							
1	Reversing Eng., Direct, 12 × 16½	¾			1	1	1																													
1	Turning Eng., 6 × 7		1½		1½	1½	1½																													
1	Main Feed Pump, VD, 8 × 5 × 12	1½			2	2	2								4		4		3	3	2½	2											3		
1	Aux. " " VD, 8 × 5 × 12	1½			2	2	2	2½	2		4	3½	4		4					3	2½	2	3					3			2½				
1	Ballast Pump, VD, 12 × 14 × 12		2½		3	3	3				7		4	10												5		10								
1	Water Serv. & Sanitary Pump, VD, 7 × 4½ × 10		1½		2	2	2				4													3	2		½									
1	Centrifugal Pump, 30 Dia.										10	7													2	9		9								
1	Centrifugal Pump Engine, V, 9 × 9		2½		3	3	3																													
1	Feed Water Heater, 244 sq. ft					4	4												3																	
1	Evaporator, V, 10 ton		2		3																							3								
1	Ash Ejector, 5																													5						
1	Windlass, 17⅞, 2 Gypsies																																			
1	" Eng., Below, V, Rev., 9 × 9 Double		2½		3	3	3																													
1	Capstan & Eng. on Deck, Rev., Hor., 6 × 6 "		1½		2	2	2																													
1	Steering Eng., Hor., Rev., 7 × 7 Double		2		2½	2½	2½																													
2	Winches, Single Gear, Rev. Drum, V, 8 × 8 D'ble		2		2½	2½	2½																													
2	Injectors	2																																		
..	Heating System			1½																																
..	Fire Extinguishers	2																																		
1	Whistle	2																																		
..	Deck Machinery		3		3½	2½	3½																													
..	Auxiliary Machinery in Engine Room		3½		4	4	4																													
1	Hand Deck Pump																																			
2	Cargo Oil Pumps, HD, 12 × 12 × 18		2½		3	3	3				10							10										8								10
2	Fuel " " H																																			
1	Generator, 10 K.W.																																			
1	Generator Engine, 6 × 6		2		2½	2½	2½																													

V = Vertical. VD = Vertical Duplex. H = Horizontal. HS = Horizontal Simplex. HD = Horizontal Duplex.

KEY TO DIAGRAMMATICAL PIPE PLAN SHOWN ON INSET.

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in a heat generator to its former temperature. See "main steam circuit" on plan, and compare the course and sizes of the piping from steam outlet back to feed supply on the boilers. It will be noted that to supply an easy access to the air pump for the vapor and non-condensible gases which are mingled with the condensed steam, the passage from the condenser to pump is many times greater than the water volume alone would require.

Owing to practical considerations and limitations, the heat-engine cycle just described cannot be attained with any degree of efficiency without the intervention of auxiliary apparatus of various kinds. The modern marine boiler, particularly the Scotch cylindrical type, does not lend itself to the use of cold feed. Such a practice entails stresses and strains of an excessive character and serious deformation and leakage, owing to the difference of temperature created between the various parts; hence, though theoretically there is no gain, the introduction and practical advantages of preheated feed by placing feed heaters, either of the ordinary or contact type, or sometimes both in series, between the feed pump and the boiler.

The filter tank is also interposed in the return circuit to prevent injurious lubricants caught up by the steam reaching the generator and doing damage there; while of the impurities which reach the boiler or are liberated there, the floating ones, or "scum," are discharged overboard through the surface blow-off, and the precipitated matter is similarly dealt with by the bottom blow.

A small but steady leakage of the operating fluid is always experienced in practical engine working, and this is made up from an evaporator connected at will with the main circuit. The addition is generally made in the form of low-pressure vapor at the low-pressure valve chest, thereby causing the added steam to do some work before condensation.

A rule applying to all marine piping service is that every function of vital importance should be carried out in case of emergencies, such as bilging, leaks, breakdowns, etc., by additional connections to one or even more machines. The regulations of classification and registration societies affecting pipe plans are all directed to securing such safeguards and to preventing, as far as possible, all danger to the vessel by careless or mistaken handling of valves and connections. In one case known to the writer a vessel accidentally bilged was prevented from foundering through the powerful assistance afforded by the bilge suction connections of the centrifugal circulating pumps, while in another the connection was useless at the critical moment, owing to the pumps being designed purely for the light duty of circulating the water through the condenser. At all points in the design of the pipe plan the engineer is preparing for the unexpected.

Make-up feed, for instance, is an absolute necessity, consequently, in addition to the evaporator supply, it is arranged to be drawn, when necessary, from the fresh-water storage tanks—usually under the engine-room floor; while, as a third and last resort, salt-water make-up is introduced from the water circulating through the condenser.

The secondary function of the piping arrangement is to convey the operating fluid to and from the various auxiliaries requiring power, and to afford suction and discharge channels for the many water pipes connected to these auxiliaries through the vessel's skin and to numerous compartments. This section, in a vessel of some size, forms by far the larger portion of the piping outfit and may be divided into two portions, viz.:

1. Auxiliaries and connections required for the propelling machinery.

2. Auxiliaries intended for the safe handling of the vessel, of cargo, and for sanitary and other water services.

In the first class are included: the air pump when independent, detached main and auxiliary condensers, feed pumps (main and donkey), turning engine, reversing engine, independent circulating pumps, evaporator, filter tank, feed heater, engine water service to bearings and for ashes wetting and ejecting, and engine drains and attached piping. Of these, the air, feed, and circulating pumps must be constantly at work in an efficient condition while the vessel is in motion, and the two latter have invariably duplicate services.

The second class embraces: the steering engine, capstan, windlass, deck winches and warping machinery, electric-lighting plant, bilge pumps, ballast pumps, fresh-water and hot-water pumps, sanitary pump, galley pump, deck pump, fire pump and fire mains, distiller, steam extinguisher service, etc. Of the above, the steering engine and bilge pumps have constant duty while the vessel is under way, and care is taken, as will be seen from a study of the chart, to duplicate the sources of steam and water service in as many cases as possible.

Where a vessel is designed for special freight services, such as oil, cattle, provisions, etc., there may be much additional outfit of special pumps and apparatus, which increases the steam demand and the complexity of the piping scheme. In the large twin-screw vessels of high speed, the machinery—which is relatively small in a slow "tramp"—reigns supreme. There the most recent practice is toward disconnected auxiliaries throughout, particularly in warships. The condenser is being made independent and sectional to allow of necessary tube repairs at sea without stoppage of machinery.

The "backing up" of small engine waste steam to 25 pounds pressure or more, known as the closed exhaust system, entails further extensions of the piping provision for auxiliaries, but at the same time utilizes their steam discharges in doing work (in main engine, evaporator or feed heater) and sensibly affects the fuel bill, which, other things being equal, is, after all, the true mercantile gage of engineering success. Recent progress would indicate that electric-driven deck machinery is practicable, and, in the turbine steamers, several auxiliaries have dispensed with independent steam motors, worm-gearing drives being used from the main engines. There is no prospect, however, of displacing the heavy outfit required for draining and ballasting vessels.

The piping arrangement is, it will be seen, a veritable encyclopedia of the vessel's machinery, equipment, and operation, and will repay close examination and criticism on the part of the marine engineer who desires to have a comprehensive grasp of his profession and duties.

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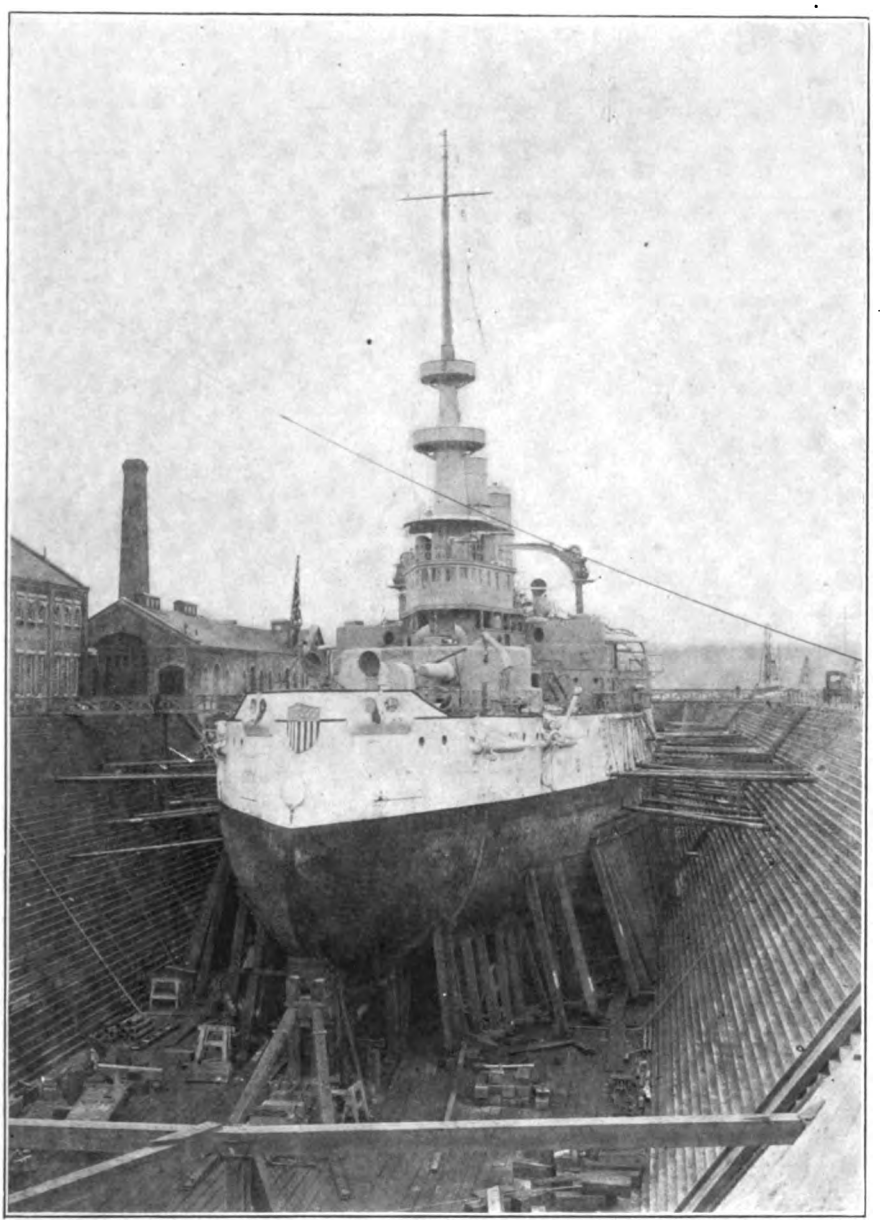
The Battleship Oregon.

As previously described in MARINE ENGINEERING, the United States battleship *Oregon* underwent very extensive repairs to her bottom, owing to grounding on an uncharted reef in the Philippines.

In order to get at the damaged plates and frames it was necessary to support a good part of the weight of the hull by shoring carried out near the bilge. The weight of the main turrets was carried by a system of heavy girders erected inside the hull, attached to the side plating, which was supported by the shoring. The accompanying view shows this splendid battleship in dry-dock at the Bremerton Navy Yard, Washington, while undergoing these repairs.



BATTLESHIP OREGON IN DRY-DOCK AT BREMERTON, WASH. SHOWING SPECIAL SHORING FOR REPAIRING BOTTOM PLATING.

THE INFLUENCE OF BILGE KEELS ON THE RESISTANCE AND THE ROLLING OF VESSELS IN STILL WATER.—I.*

BY JOHANN SCHUETTE.

The influence of bilge keels on the rolling of ships has often been the subject of the highest technical consideration, but much more rare has been a discussion of the influence of bilge keels on the resistance to the forward motion of the ship in still water.

Fully a year ago the head of the experimental station of the North German Lloyd at Bremerhaven was commissioned by the German Navy to make experiments in

*Specially translated for MARINE ENGINEERING from a paper read before the *Schiffbautechnische Gesellschaft*, Berlin, November 26, 1902.

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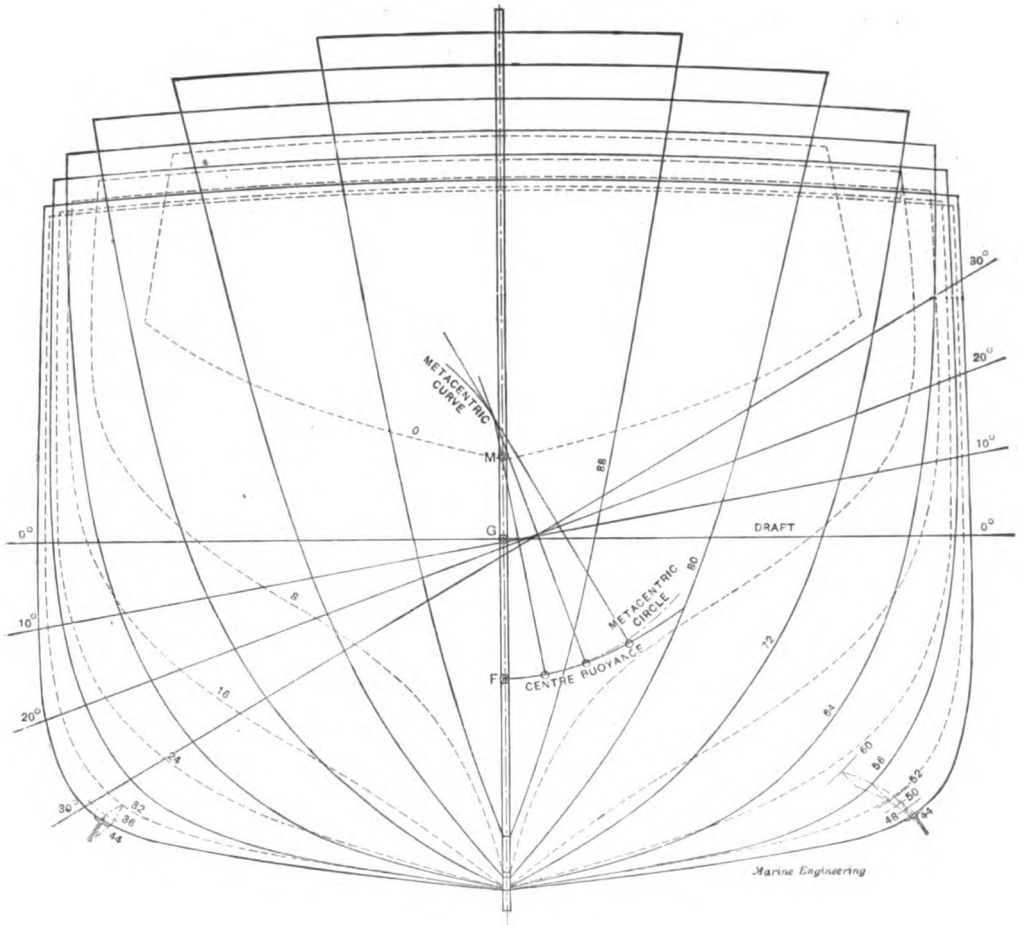

FIG. 1.

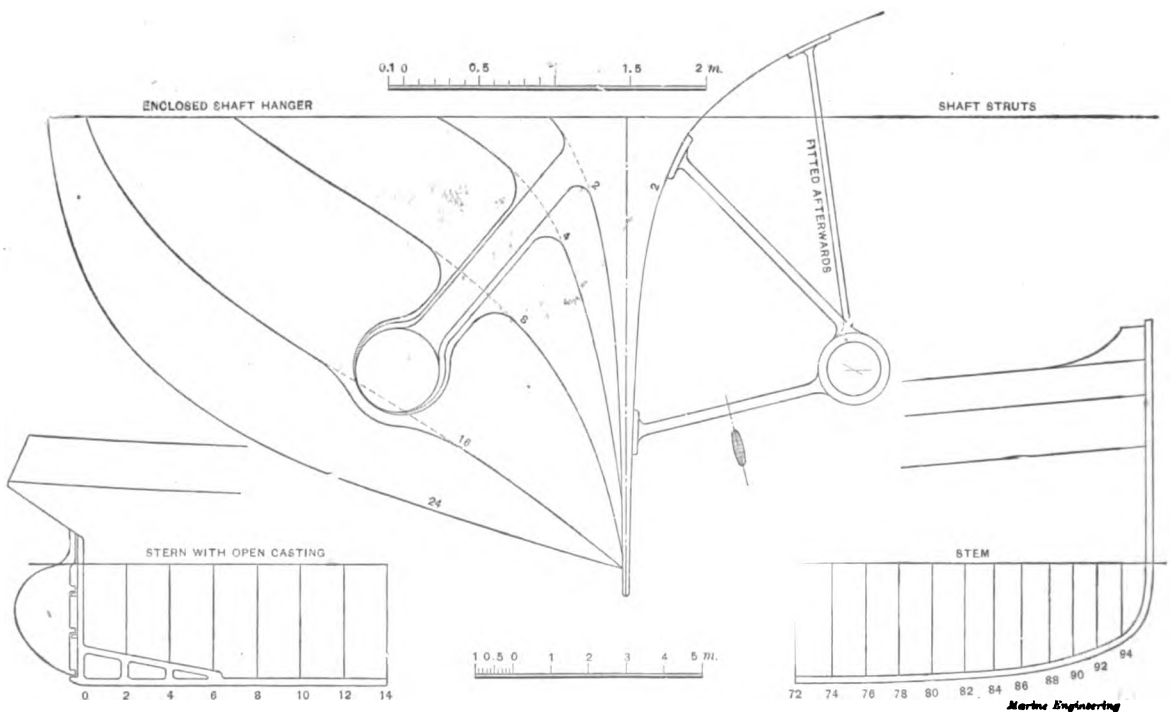

FIG. 2.—STEAMER SKEADLER: LENGTH, 50 M.; BEAM, 8 M.; DISPLACEMENT AT 3 M. DRAFT, 526 TONS.

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their tank with a model of a small cruiser, and to determine to what extent the resistance was augmented by the bilge keels. These and several investigations have led to very interesting results, which perhaps will lead to the further question as to how the bilge keel should be placed in order to give the least resistance.

A model to 1-25 scale was made of a small cruiser of the following dimensions:

Length	341 ft. 0 in.
Beam	42 " 8 "
Draft	16 " 5 "
Displacement in salt water, about	5,050 tons.

This was towed through the water at different speeds corresponding to speed of the ship. The effective horse powers were figured from the derived model resistances from the formula:

$$E.H.P_{total} = .0070356\alpha^3 Vw - .0025887L^{.0875}(O_M - O_S) \times F.V^{2.895}.$$

V = Model Speed in Meters per sec.	Model Resistances in grams.		Difference $b-a$.	Difference in per cent. of a.
	a Without Bilge Keels.	b With Bilge Keels.		
1.029	476	521	45	9.4
1.132	575	630	55	9.5
1.235	685	751	66	9.6
1.338	814	889	75	9.2
1.440	954	1035	81	8.5
1.543	1103	1195	92	8.3
1.646	1261	1378	117	9.2
1.749	1442	1585	143	9.9
1.852	1642	1811	169	10.2
1.955	1871	2045	174	9.2
2.058	2125	2295	170	8.1
2.161	2416	2600	184	7.6
2.264	2825	3073	248	8.7
2.366	3437	3750	313	9.1

COMPARATIVE RESISTANCES OF MODEL WITH AND WITHOUT BILGE KEELS.

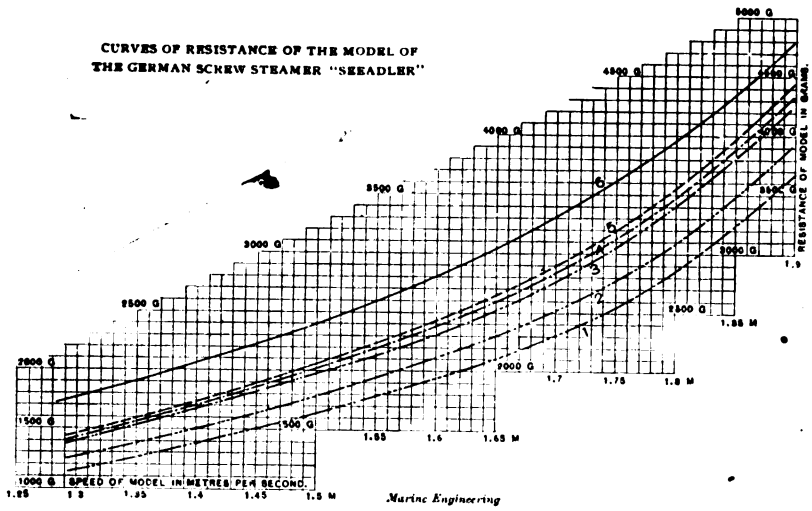

FIG. 3.—SCALE, 1 = 12.5.

This formula was derived from Froude's theory for resistance of ships, which was modified by me through the introduction of the proper constants and read in a paper in the second volume of the transactions of the *Schiffbautechnische Gesellschaft*. In the formula—

α is the relation between the lineal dimensions of the ship and the model.

V the ship's speed in knots.

w the model's resistance in kilograms for the corresponding speed. $V_m = \frac{.5144\,V}{\sqrt{a}}$.

O_M and O_S constants depending on the relative wetted surface of the model and the ship.

L the water-line length of the ship in meters.

F the wetted surface in square meters.

The following tables give us the resistance of the model firstly without bilge keels, secondly with bilge keels, and the corresponding effective horse powers.

The bilge keels, according to these tables, increase the resistance 9 1-2 to 10 per cent., therefore, from a practical standpoint, if the cruiser travels 50 days in the year at full speed at 22 knots, the increased resistance due to the bilge keel costs $3,750, if we figure .8 kg. coal per H. P. per hour, and coal at $3.50 a ton.

Ship's Speed in Knots.	Effective Horse Power.		Difference $b-a$	In per cent. of a.
	a Without Bilge Keels.	b With Bilge Keels		
10	327	366	39	11.9
11	438	491	53	12.1
12	575	644	69	11.9
13	751	835	84	11.1
14	960	1057	97	10.1
15	1201	1320	119	9.9
16	1477	1643	166	11.2
17	1815	2035	220	12.1
18	2216	2494	278	12.5
19	2704	3001	297	10.9
20	3281	3578	297	9.0
21	3980	4317	337	8.5
22	5008	5511	503	8.0
23	6622	7304	682	10.3

COMPARATIVE RESISTANCES REDUCED TO HORSE POWER.

Although by a change in the arrangement of position and the length of the bilge keel the total resistance may be reduced 4 1-2 per cent., there still remains an increase of 5 per cent. in the total resistance due to the bilge keels, which should cause deep thought to all engineers interested in the economics of vessel propulsion.

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According to the newspapers the Americans contemplate building a four-day ocean steamer, which would mean a speed of at least 30 knots. I do not consider the design of such a vessel as involving any technical difficulties, particularly since German ingenuity and industry have evolved a vessel of considerably smaller dimensions having over 40,000 H. P. However, it would be a much more difficult thing to make a vessel of this sort commercially practicable, owing to the first cost and cost of maintenance.

Undoubtedly we Germans have made remarkable progress in the last 20 years in the subject of shipbuilding and marine engineering, and we have arrived at dimensions and speeds which were 20 years ago undreamed of, I do not believe, however, that there will be corresponding progress in the next 20 years unless radical departures are made in the form of vessels and the production of power.

As before mentioned, the model experiments of the small cruiser were the cause of further investigations on the subject of bilge keels. In Figs. 1 and 2 is shown the construction of a tugboat of the N. G. L. of 50 meters length (164 feet), 8 meters (26.24 feet) beam, which has a displacement of 526 cubic meters (which is 532 tons in salt water) at 3 meters (9.84 feet) draft without appendages. The model of this tug, to the scale of 1 to 12.5, was towed at the same draft six times.

1st, with a rudder and without shaft hangers.

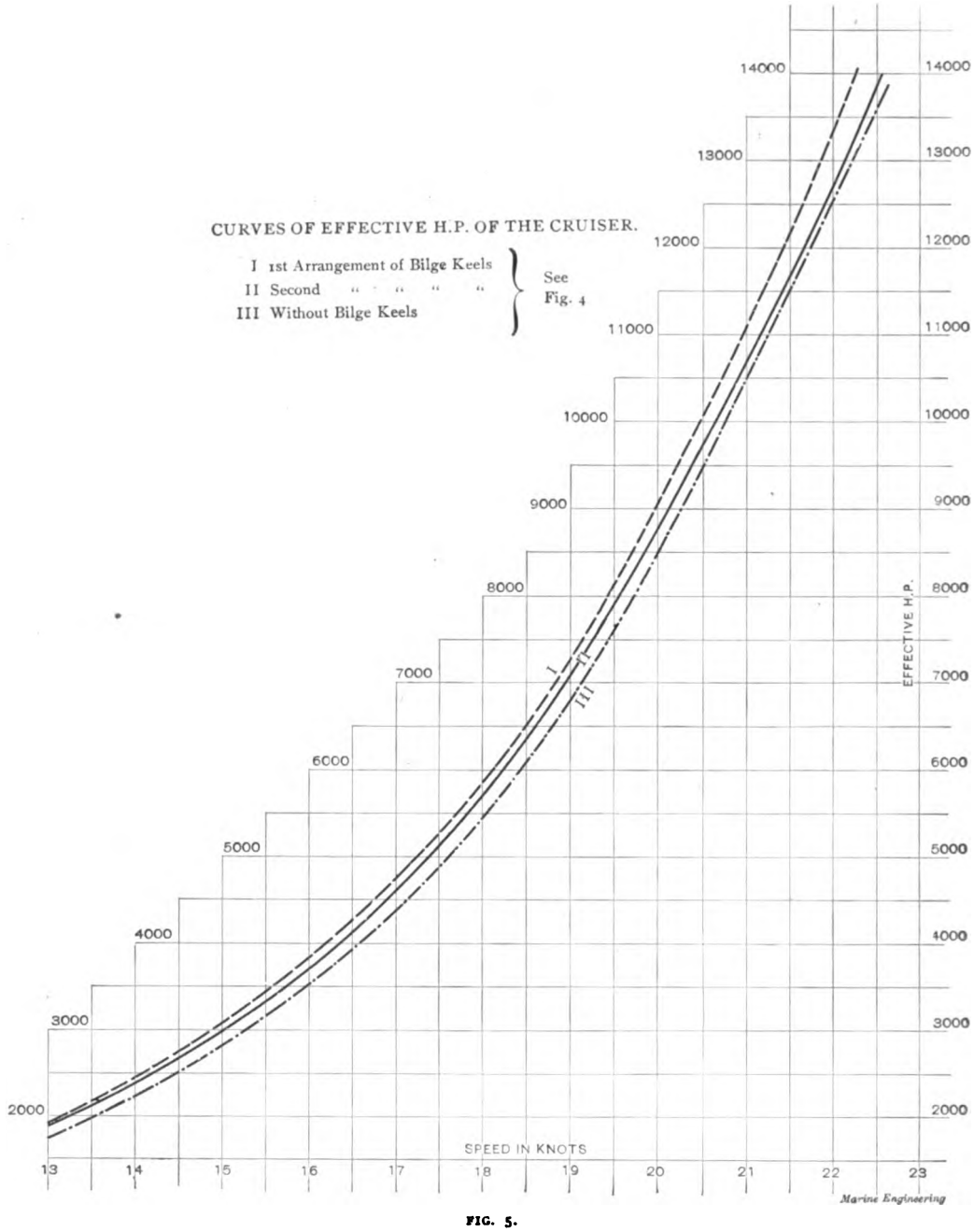

FIG. 5.

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2d, with the rudder and encased shaft hanger,

3d, with rudder and shaft hanger,

4th, with the rudder, shaft hanger, and bilge keel,

5th, the same as 4 with the addition of an open, sternpost casting,

6th, the same as 5 with further addition of the screws.

The results of these experiments are shown in Fig. 3 and the following table:

per ton, we find the cost of this bilge keel from the above table to be $335.00.

This result is much more favorable than that shown on the cruiser. It is explained, however, by the difference in length and position of the bilge keel.

In the small cruiser the bilge keels were 48 per cent. of the vessel's length, while in the tug they were only 33 per cent.; in addition the ends of the bilge keels of the

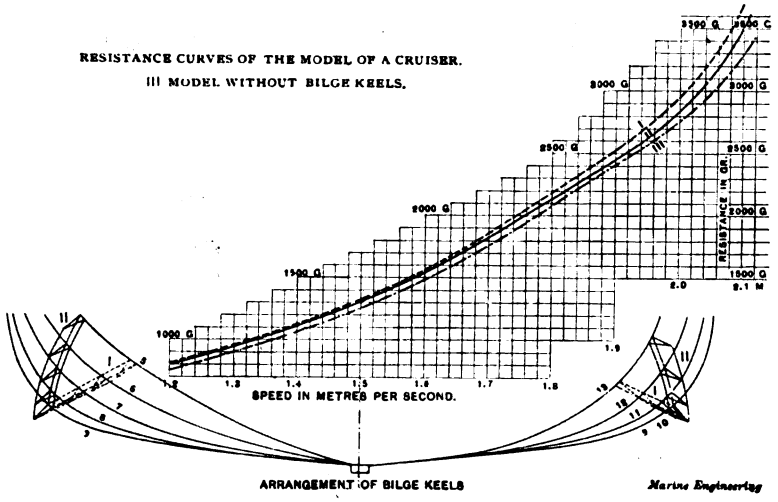

FIG. 4.—SCALE, 1 = 35.

Knots.	1 With Rudder only.	2 With Rudder and Enclosed Shaft Hanger.	3 With Rudder and Struts.	4 With Rudder, Struts, and Bilge Keels	5 With Rudder, Struts, Bilge Keels, and Stern Casting.	6 With Rudder, Struts, Bilge Keels, Stern Casting, and Screws.	Knots.
6	26	30	37	37	38	47	6
7	44	50	58	59	61	76	7
8	68	78	90	91	93	119	8
9	104	115	132	134	138	175	9
10	154	169	196	199	203	247	10
11	219	242	272	280	287	341	11
12	319	354	400	409	420	488	12
13	519	501	618	629	646	706	13
12.61	423	469	517	533	547	613	12.61

RESISTANCES WITH DIFFERENT APPENDAGES.

As the speed of the vessel with 3 meters (9.84 feet) draft and 875 I. H. P. in both engines gave 12.61 knots, we have, through the division of this I. H. P. into E. H. P., the following results:

875 H. P.	1	2	3	4	5	6	875 H. P.
12.61 Kts.	48.3%	53.6%	59.1%	60.9%	62.5%	70%	12 61 Kts.

The coal consumption during the trial trip showed .98 kg. per H. P. (2.16 pounds). If we take 150 days at full speed for this tug, and as we figured coal at $3.50

cruiser turned toward the centre, consequently the projection of the bilge keel on the body plan was correspondingly greater than in the tug. The foregoing table teaches us, however, other quantities besides bilge keels influence resistance. If the tug was not fitted with shaft hangers, stern casting, and bilge keel, but with an unencased shaft hanger, unbroken dead wood, and no bilge keel, we would have had with the I. H. P. not 12.61 knots, but 12.95 knots, or, with the same speed, we would have saved 78 E. H. P. or 145 I. H. P. If we, therefore, compare Nos. 2 and 5, we find the cost of the bilge keels, under similar circumstances, figure, as before, $1,790.00 annually in coal. Other experiments, which are represented graphically in Fig. 9, show these conditions did not hurt the sea qualities of the tug, as the swing curves 5 and 9, as shown in this figure, lie very closely together, and the period of a double swing only varies .03 second for the model or 1-10 second for the ship.

In this connection I should like to return once more to the theoretical calculation of ship resistance. Among the fourteen theories of which I am more or less familiar which deal with this subject, it is my belief that the results in the foregoing table of I. H. P. could be figured from none; they are all based, if not on unmeasured, very often on unknown constants, and their calculation is extremely difficult. Distinctions such as the table shows can only be derived from model experiment.

We, therefore, look with great regard upon the action of the German Navy Department, which has, with untold difficulties and cost, instituted an experimental department which will have as its aim, as does the experimental station of the North German Lloyd, the development of vessel forms and propellers. I refer to the experimental station for vessel construction and naval architecture in Berlin.

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In Figs. 4 and 8 the further results on the position type and length of bilge keels and their corresponding increase in resistance are shown. The curves in Figs. 4 and 5 show us that although in conformation with the construction of the double-bottom docks, dry-dock gates, etc., etc., it is customary to run the ends of the bilge keels toward the center. It is known, however, that they should be turned to a minimum toward the center, but rather to be turned upward, as the direct resistance is considerably lessened by this means.

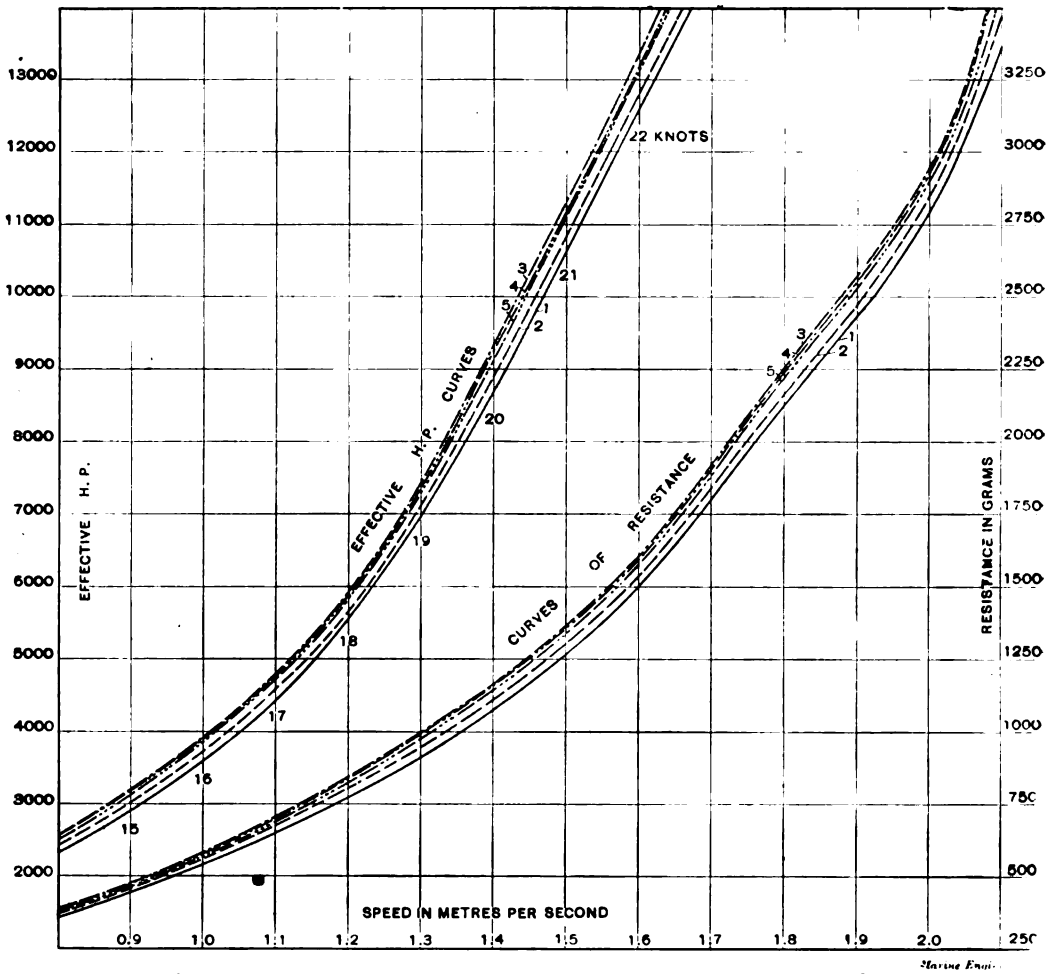

FIG. 6.—LARGE CRUISER. SCALE, 1 = 35. LENGTH, 125 M.; BEAM, 20 M.; DRAFT, 6.89 M.

After the results of the bilge keels resistances, as shown in Figs. 4 and 5, were determined in principle, experiments were made on four models of a larger cruiser, 125 meters (410 feet) in length, 20 meters (65.6 feet) beam, 6.89 meters (22.5 feet) draft. Of these, three were of the same length but of different height, and the fourth, or shortest one, was the result of the experiment. Of this I will speak later.

After investigating these bilge-keel trials and figuring the effective horse power from the model experiments, we find the bilge keels No. 5 on Fig. 6, which are 48 meters long, .6 meter high at centre, and .8 meter high at the end, to be the most efficient. In spite of this the cost of driving a ship, if we assume a large cruiser with 100 full days steaming at 21 knots as a criterion, the increased cost, figuring coal at $5.00 per ton, would be $8,000.00 annually. Similar trials to those with the model tug and the cruiser were made on models of a large transatlantic steamer of high speed, and also on those of a large freighter. These results are given in Figs. 7 and 8. The bilge keels increase the resistance of the liner from 2.8 to 5 per cent.; on the freight steamer only 1.6 to 1.9 per cent., although the bilge keel was 52 1-2 per cent. of the total ship's length. From these figures, figuring the *Kronprinz Wilhelm* as steaming 105 full days at 23 knots, we find an annual cost of $9,120 due to the bilge keels, with coal at $3.50 per ton, while for the freighter, with 200 days full steaming at 13 knots, the increase will be only $775.00. All the trials here mentioned on bilge keels depend, of course, on smoothly-built bilge keels running even with the strakes. The accompanying Fig. 10 shows the sections of the different keels.

It is assumed in all these cases that bilge keels will be used, in spite of the increased cost and the eventual damage to the boat, on small ships with fine form, that is to say, by small ships in which the first consideration is high speed. These bilge keels, however, should not be over .3 the length on small boats and .38 on the large ones, and the ends should be run at such course that the

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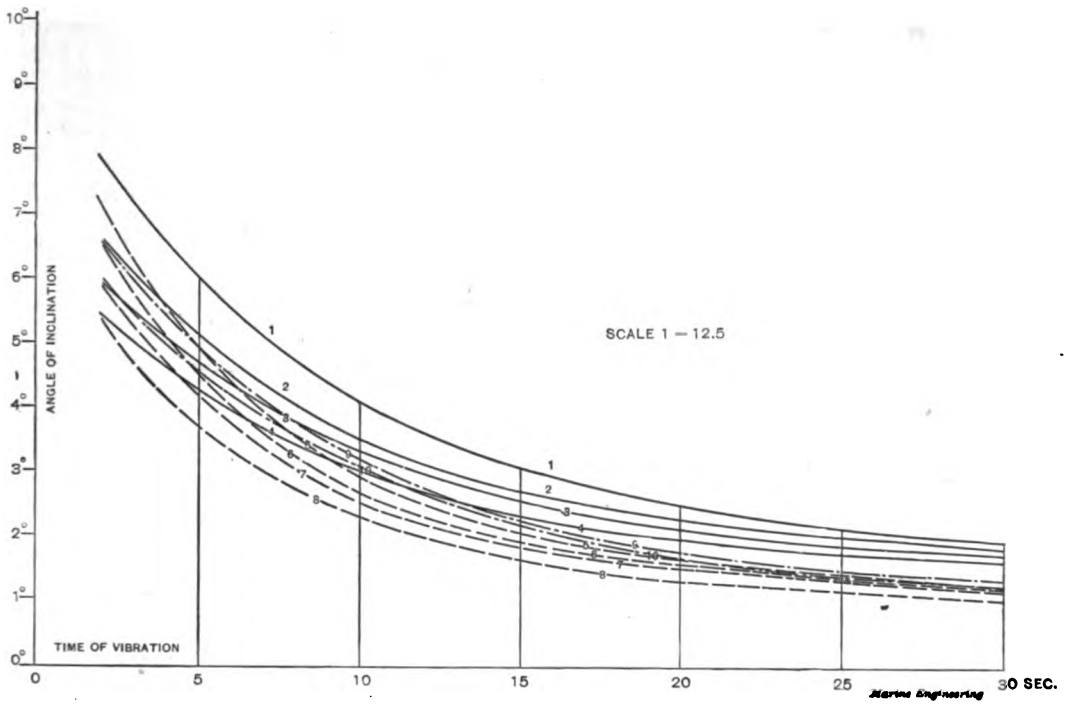

FIG. 9.—STEAMER SEEADLER.

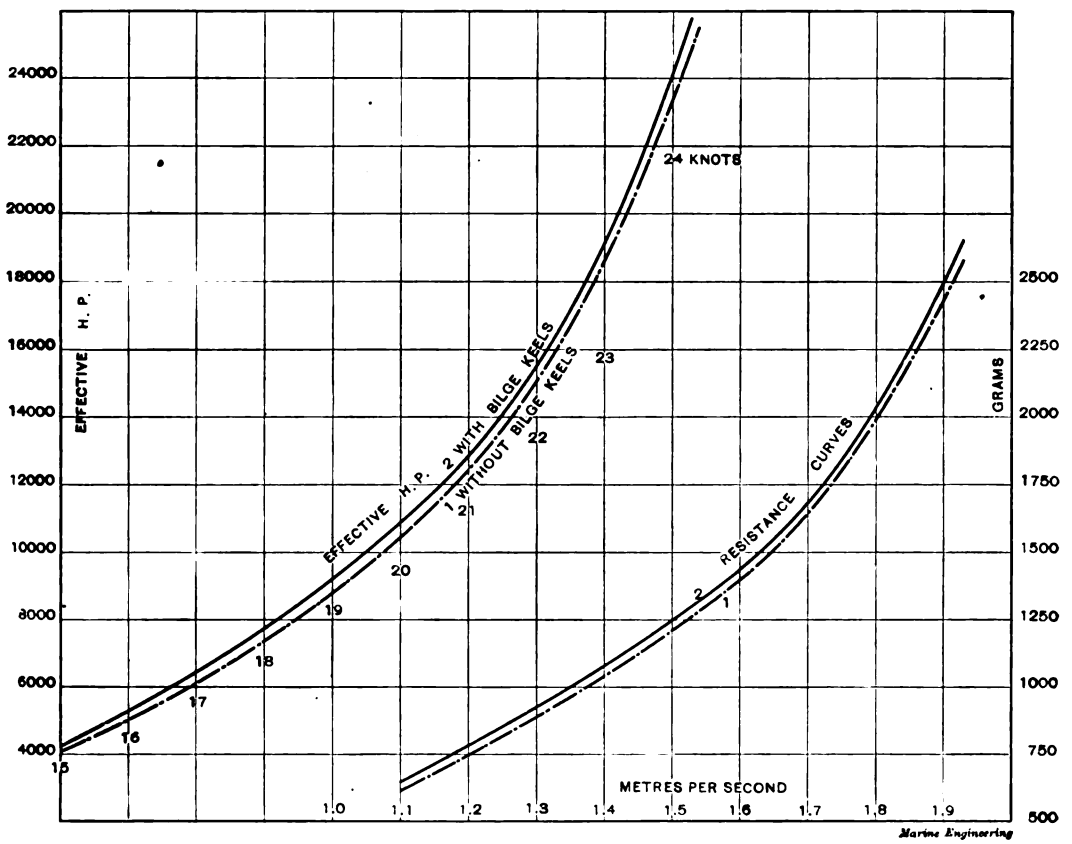

FIG. 7.—STEAMSHIP KRONPRINZ WILHELM. SCALE, 1 = 45. LENGTH PERPENDICULARS, 193.54 M.; BEAM, 20.10 M.; DRAFT, 8.185 M.

With Encased Shafts, Displacement 19,625 tons; Wetted Surface 5,190 sq. m.

With Encased Shafts and Bilge Keels, Displacement 19,634 tons; Wetted Surface 5,270 sq. m.

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projection of the bilge-keel surfaces shall be a minimum on the longitudinal section of the boat.

This last question will often necessitate a drawing up of the bilge keels, particularly at the stern of the vessel.

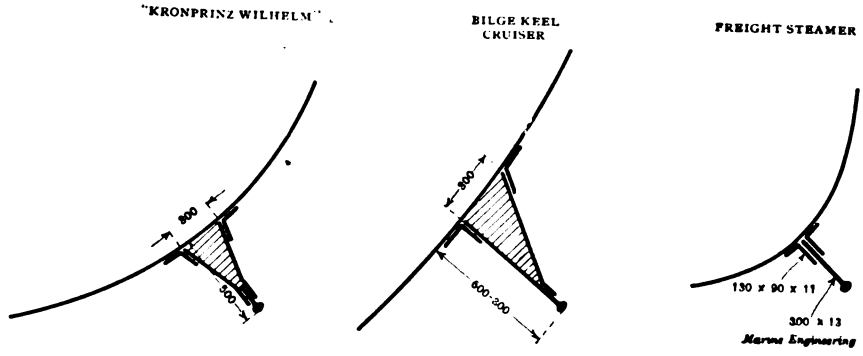

FIG. 10.

On large freight steamers with long, dead-flat midship portion, without particularly increasing cost of operation, the bilge keels can be carried for full half length amidships.

The question of whether bilge keels should be used or not can only be determined, from my point of view, if we compare their effect on the rolling of the ship together with the increased cost which is due to the increased resistance of the vessel.

Without doubt the uses of the bilge keels are many, and should be recommended in spite of the increased cost for vessels of war, where the effect of rolling is such that the efficiency of the gunfire is seriously impaired, where an increased efficiency in that respect is greatly desired: and even in merchant vessels the bilge keel should not be looked upon merely as fashion.

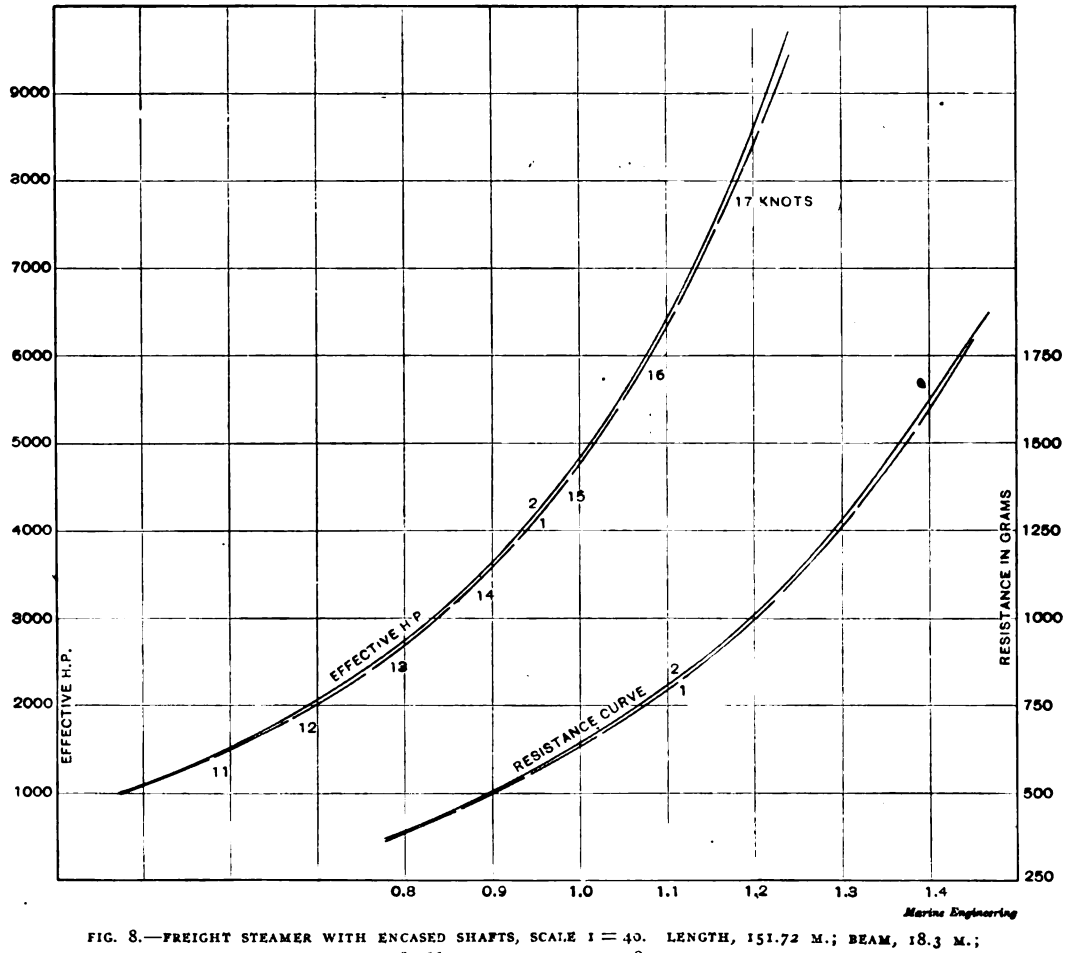

FIG. 8.—FREIGHT STEAMER WITH ENCASED SHAFTS, SCALE 1 = 40. LENGTH, 151.72 M.; BEAM, 18.3 M.; DRAFT, 8.966 M.; BILGE KEELS, 79.8 M. LONG.

Without Bilge Keels, Displacement 18,535 tons; Wetted Surface, 4,543 sq. M.
With " " " 18,540 " " " 4,607 " "

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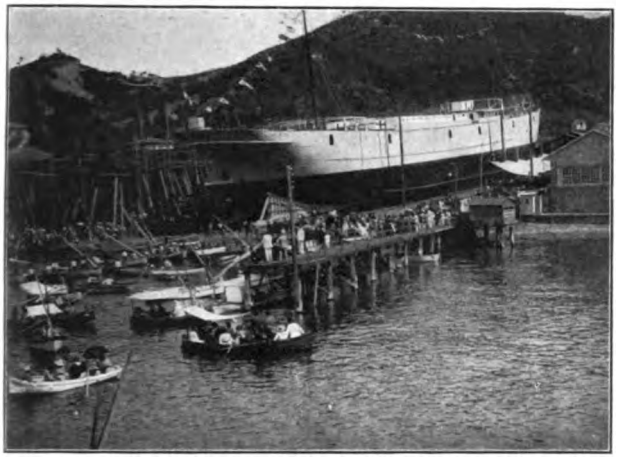
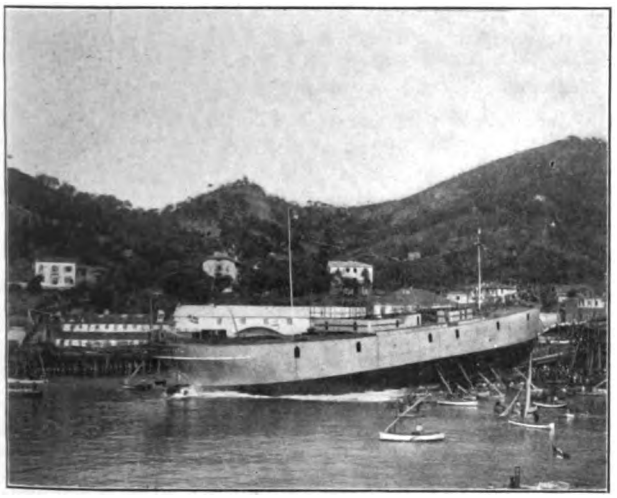


LAUNCHING THE TIEMONTE ON THE GULF OF SPEZIA.

LAUNCHES.

Picturesque Launching.

The accompanying photographs are of vessels launched from the picturesque yard of Mugdiano, on the Gulf of Spezia, on the Ligurian coast of Italy. It would appear that, owing to the proximity of the hills, there was not room for a large yard to be established at this point and that the output would be small. Our correspondent, however, advises us that the yard



LAUNCH OF THE PRINCIPENA LACTITIA.

covers nearly 580 acres. It is located behind the Crandrella Point, is protected from the south winds by a breakwater built across the mouth of the gulf. The bay also has the advantage of being protected by fortifications, so that the yard would be of great service in time of war. The output since the year 1898, when the yard was established, has been increasing, and in 1900 five vessels were launched of nearly 20,000 net tons. In 1901 four ocean steamers were launched, one, the *Tiemonte*, belonging to the Luigi Capuccio Company, being the largest cargo boat in the foreign merchant marine. The vessel is of steel, awning-deck type, 390 feet long over all, with a carrying capacity of 7,800 net tons on 24 feet draft. During the last year five large ships were launched from this yard, including the *Principena Lactitia*, of which a description is herewith given, and three small ones. There are six building ways, varying from 340 to 560 feet in length.

The *Principena Lactitia*, the last vessel to be launched, belongs to the Luigi Capuccio Company, of Corino, and is of the following dimensions:

NAME—Principena Lactitia. NATIONALITY—Italian. BUILDER—Mugdiano.
TYPE—Ocean Freighter. LAUNCHED—1902. OWNER—Luigi Capuccio Co.

Length over all	339 ft.
Between perps.	324 "
Beam	48 "
Depth	25 " 3 ins.
Load draft	21 " 6 "
Load displacement	
Gross tonnage	7,564 tons
Engines, type	three-cylinder, triple-expansion
I. H. P.	2,100
Cylinder diam	24, 40, 66 ins.
Stroke	48 "
Revolutions on trial	85
" in service	76
Steam pressure	160 lbs.
Valves	Piston for H. P.; slide valves for M. P. and L. P.
Framing	Cast-iron columns
Bed plate	Cast iron
Condens, surf.	2,605 sq. ft.
Shafting, crank	13 3-8 ins.
" line	12 7-8 "
" propeller	14 1-4 "
Propeller, type	four blades
Diameter	16 ft. 6 ins.
Pitch, variable	17 " 6 " to 17 ft.
Projected area	82 sq. ft.
Boilers, number	2
Type	single-end Scotch
Length	11 ft. 6 ins.
Diameter	14 " 9 "
Number of furnaces in each	3
Inside diam. of furnaces	44 ins.
Length of grates	5 ft. 3 1-2 "
G. S. total	112 sq. ft.
H. S. " "	4,418 " "
Tubes, number in each	381
" diameter	2 1-2 ins.
Tubes, length	7 ft. 9 "
Howden draft	
Speed, full load	10 1-2 knots
H. S. ÷ G. S.	39.44
H. S. ÷ I. H. P.	2.10
I. H. P. ÷ G. S.	18.75

Steamer Tionesta.—The steamer *Tionesta*, recently launched for the Erie and Western Transportation Company from the Wyandotte works of the Detroit Shipbuilding Company, is a practically new type of vessel for the Great Lakes. She is designed for the passenger service of the Anchor Line between Buffalo and Duluth, and will also be a large package freight carrier. She is what on the coast might be termed of the "intermediate" type. The Anchor Line has several smaller vessels of this class, but the *Tionesta* is the forerunner of the large passenger and freight steamer. The principal dimensions are: length over all, 360 feet; keel, 340 feet; beam, 45 feet; depth, 28 feet. Her double water bottom, extending throughout, is of 900 tons capacity, while the cargo capacity is 3,500 tons and the coal bunkers 350 tons (all net tons). There are accommodations on the upper promenade deck for 350 passengers. Four lines of state rooms extend from the forward bulkhead to the stack, and on the promenade deck amidships is the

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dining saloon, with a seating capacity of 136 passengers, and other large state rooms. The vessel is propelled by a quadruple-expansion engine with cylinders 22, 31 1-2, 45, and 65 inches diameter, with a common stroke of 42 inches. This engine when running at 100 revolutions per minute is designed to indicate about 2,500 horse power. Steam is supplied at 210 pounds pressure by three cylindrical boilers 12 feet 6 inches in diameter by 11 feet 3 inches long, equipped with forced draft.

Six-Masted Schooner.—There was recently launched from the yard of Percy and Small, Bath, Me., the six-masted schooner *Addie M. Lawrence,* 292 feet long, 48.3 feet broad, 22.2 feet deep, with a gross tonnage of 2,807. This firm built the *Eleanor F. Percy.*

Steamship Minnesota.—The ship *Minnesota,* built by the New York Shipbuilding Company for the Atlantic Transport Company, was launched on December 15. The vessel is 490 feet in length over all, 58 feet extreme molded breadth, 27 feet depth of hold. She will have a carrying capacity of 10,000 tons and will be fitted for carrying 900 head of cattle.

Fishery Protection Steamer.—The oaken steamer *Kestrel* is nearing completion at the yard of Mr. A. Wallace, Vancouver, B. C., and is to be used by the Canadian government in policing the northern fishing waters. The vessel is 145 feet long over all, 24 feet beam, and 13 1-2 feet deep. She has a compound engine with cylinders 18 and 38 inches by 24 inches, which drive the vessel at a maximum speed of 12 knots. She is to carry a crew of fifteen men besides her officers. The accommodations are very handsomely finished in quartered oak.

Steamer John B. Cowle.—On October 2 the steamer *John B. Cowle* was successfully launched from the plant of the Jenks Shipbuilding Company, Port Huron, Mich. The new vessel is built for W. W. Brown and others, of Cleveland, and is a sister ship to the *Henry Steinbrenner,* recently launched at the Jenks yard. The dimensions of the new boat are: Length over all, 440 feet; on keel, 420 feet; beam, 50 feet; depth, 28 feet. The engine is triple expansion with 23, 37, and 63-inch cylinders, all of 42 inches stroke. Steam is supplied at 185 pounds pressure by three Scotch boilers 12 1-2 by 12 feet.

Oil-Tank Steamer.—The oil-tank steamer *Spondilus,* launched from the yard of William Gray and Company, has been added to the petroleum-carrying fleet of the Shell Transport and Trading Company, Ltd., London. The dimensions of the *Spondilus,* which is a sister ship to the *Pectan,* are: length over all, 483 feet; beam, 55 feet; depth, 34 feet 10 inches. The water bottom is fitted the entire length of the vessel. The engines and boilers are placed aft and the cargo space is divided by thirteen transverse and one fore-and-aft bulkheads from the keel to the main deck. The holds are so constructed that the vessel may be used for general cargo, if desired. The triple-expansion engine has cylinders 29 1-2, 48, and 78 inches diameter by 54 inches stroke. The six single-end boilers are fitted for burning oil on the Flannery-Boyd system with Rusden and Eeles burners.

SCHOOLS FOR MARINE ENGINEERING AND NAVAL ARCHITECTURE.

The Naval Architecture Department of the Durham College of Science, Newcastle-upon-Tyne, England.

BY GEORGE CROUSE COOK.

In the month of October, 1871, the University of Durham and the North of England Institute of Mining and Mechanical Engineers jointly established the Durham College of Science, at Newcastle-upon-Tyne, England, by the reorganization of the old school, which was specifically known as the University of Durham College of Physical Science.

The support of the college is to a certain extent gained from voluntary contributions, and these subscribers or their representatives compose the registered incorporated society which, in the terms of the constitution, stands for the college. These subscribers, among whom are the prominent shipbuilders and engineers of the district, are called governors, and the actual executive of the college is held by a council consisting of certain officers of the university and college, together with certain governors elected from and by this body. The present staff of instructors consists of twelve head professors, together with some fifty assistant professors and lecturers and an independent staff of examiners who are drawn from the different colleges and universities of England.

The grounds occupied by the college are well situated some three-fourths of a mile from the center of the city of Newcastle, and are of some six acres in extent; this includes, in addition to the building ground, a botanical garden, plots for the demonstrations of the agricultural department, and several tennis courts. The main building of the college is a broad, rectangular block built up about the quadrangle. The most prominent feature, one of which all Newcastle is proud, is the central gateway tower, which was erected as a memorial of the Royal Jubilee of 1887. In addition to this main building is the picture gallery of the Newcastle Exhibition of '87, which was taken down and re-erected on its present site for the work of certain of the departments and to give accommodations at the college for the men students.

There are at present well-developed courses in mathematics, engineering, mining, naval architecture, classic and modern languages, education and art, as well as the specific work of the natural sciences. Regular students in these courses who have followed the lectures and classes for two sessions may enter an examination for the University title of A.Sc.—that is, Associate of Science—and these associates, after the third session work, become candidates for the full degree of Bachelor. In addition, the college confers the advanced degrees of Master and Doctor after certain requirements in original professional work have been fulfilled. Certificates of efficiency are granted to students not entering the regular degree course, but who attend the lectures and qualify in the class examinations for certain specific work in the courses of agriculture, engineering, or mining. Students entering the regular courses with the object of gaining the degree are

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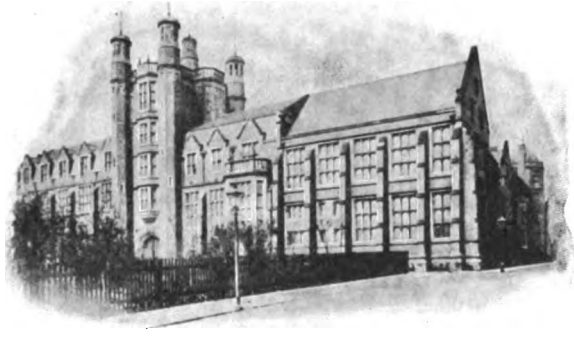
termed matriculated, and must qualify in an entrance examination or present certificates of equivalent proficiency. Non-matriculated students, or those taking up special studies only, as naval architecture or engineering, are not required to pass entrance examination, while they have quite the same general privileges as the former class.

The study of naval architecture is, as usual, a part of the three-years engineering course for the degree in science. This course, as a whole, embraces the following work: First year—mathematics, theoretical and practical physics and chemistry. Second year—applied mechanics, engineering practice, physics or chemistry, and naval architecture with drawing. Third year—advanced engineering, chemistry or physics, naval architecture and drawing. The general work of the course follows the usual lines, with the exception that particular stress is laid upon the practical development of each subject, and to this end the laboratories of the college are as complete and well equipped as the best in England. The study of naval architecture, which first appears in the second year of the course, begins with Junior class work requiring an attendance of six hours per week, and embraces the leading topics of construction, laying off, calculations and drawing. The Senior class—that is, the class of the third year—continues the work of the previous, and with an attendance of six hours per week, embraces the leading topics of practical construction, laying off, advanced calculations, propulsion of ships, and advanced drawing. For the subject of steam propulsion the students in naval architecture enter the regular class in marine engineering.

The lectures of the Junior class relate to various details under the principal topics, as follows: Construction—detail of transverse and longitudinal stiffening; properties of the different shipbuilding materials; riveting, templating, working, and erecting; preparation of working plans—*i. e.*, plans of the midship section; forgings, keel and keelsons, bulkheads, decks, shell plating, etc. Laying off—explanation of sheer draft; fairing; expansion of cant frames, stern plating, shell plating, and masts; preparation of scrieve board. Calculations—areas, volumes, weights, etc., of various bodies; areas of curved-line planes by the different rules; principles of displacement and flotation; volumes, centers, and coefficients of varying displacements; areas, centers, and coefficients of midship sections; areas, centers, and moments of inertia of water planes; tons per inch and variation of draft in salt and fresh water; initial stability and metacentric diagrams; weights of materials. The drawing of this year follows the lines of the lectures and consists of the drafting of various details of construction and working plans, together with the calculation and plotting of the different curves of form, as displacement, tons per inch, coefficients of sections, etc.

The lectures of the Senior class carry on similar work under the respective leading topics, which may be detailed as follows. Practical construction—systems of ship construction and details; methods of erecting; relative merits of wood, iron, and steel; efficiency of riveted laps and butts; details of structures and relative thickness of plates. Laying off—drafting of 3-4-inch lines; fairing on loft floor; expansion of involved forms as poop round, turtle back, etc. Calculations—the areas, volumes, etc., of complex figures; proofs of the various rules for plane areas, with methods of application in specific cases; curves of displacement, tons per inch, section area, wetted surface, etc.; centers of buoyancy, flotation, and gravity; moments of inertia and metacentric stability by approximate and accurate methods; curves of statical stability; effect of dimensions on curve; effect of stability of bilging, shifting cargo, coal consumption, etc.; cross curves of stability; experimental center of gravity; calculations for trim, moment to alter trim by various methods, with proofs; alteration of trim due to shifting of weights; dynamical stability; Moseley's formula; relation between statical and dynamical stability; oscillations of ships; properties and formation of waves; strength of ships; the curves of loads, sheering force, and bending moment;



COLLEGE OF PHYSICAL SCIENCE, DURHAM UNIVERSITY.

parts of structure resisting stresses; neutral axis, equivalent girder; local and structural strength; tonnage, deadweight and freeboard measurements. The Senior class drawing begins with the preparation of the plans and material order for a cargo steamer. These plans are developed for a merchant steamer of a given type, to carry a specific weight of cargo and coal on a given draft at a certain speed. The method followed is to first approximate the displacement, dimensions, freeboard, and tonnage, and then rough out the lines for the horse power and weight calculations. This work may show errors in details, which are corrected and the lines faired and plans completed. When this part of the design is finished, investigation is made of the conditions of stability, etc., as far as the time of the session and the industry of the student will permit.

The classes in engineering treat the subjects of mechanics, hydrostatics, steam, the steam engine, machine design, and propulsion of ships. The advanced engineering of the third year, which should be followed by the student of naval architecture, has special relation to the marine engine and boiler, and consists in detail of the following: Marine Boilers—the determination of dimensions of boilers under different conditions of working pressure, type, and steam expansion; the

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weights of boilers, and insurance rules governing the design. Marine Engines—the determination of dimensions of engines for the conditions of economy, space occupied, and weight; piston speeds and revolutions; relation between revolutions, mean pressure, and horse power developed. Propellers—the dimensions of propellers to fulfill given conditions, efficiency of various types; effect of diameter, pitch, and surface. Propulsion of Ships—water resistance to motion; influence of form and dimensions on the resistance. Methods of estimating power and speed; Admiralty coefficient; augmented surface method; Kirk's analysis; law of corresponding speed and its practical application; speed trials; progressive runs; recording speed and power curves; application of these results to different types in practice.

For students not able or desirous of taking up this complete degree course, an excellent modification stands in the "certificate of proficiency" work, which consists of attendance at certain of the regular classes in mathematics, physics, and engineering, together with the Senior and Junior courses in theoretical naval architecture and drawing. This work may be carried out over a period of two or three years, and is one which would be particularly suited to foreign students needing the mathematical training necessary to follow intelligently the advanced theoretical work of naval architecture, but who had no particular interest in the complete course required for the degree. During the summer vacation of two and one-half months, and the Christmas and Easter holidays, the Durham student has exceptional privileges for entering the neighboring shipyards, which are usually closed to strangers, and by careful observation he may learn the advanced and economical methods of working for which the builders on the Tyne are noted.

Evening classes have been established in all of the departments to carry on the broad and liberal idea of the foundation of the college, which was to offer instruction to all persons. The students of these classes have the same college standing and divisions as the day students, and are also eligible to the titles and degrees of the university. The arrangements are such that the student who has qualified in an entrance examination and performed the work of the class during a period of four years is qualified to take the final degree examinations. In a similar manner the work of the "certificate of proficiency" course is carried on, and simple attendance at the classes is allowed on payment of the fees. This offers a splendid opportunity to the working draftsman or shipbuilder of the neighborhood to acquire a degree, certificate, or the general class knowledge of his subject.

The cost of a year's attendance—that is, from the middle of September to the end of the following June—in these two naval architecture classes can be approximated as follows: Board and lodging at the "Hostle," which is the officially recognized residence for men students, can be had for $260 per school year, while the college fees for matriculation, naval architecture lectures, and drawing could be covered by $60. In addition to this would come traveling expenses to and from Newcastle, and incidentals for books, instruments, local excursions, etc., which are practically within control. The cost of living could also be more closely brought in hand by taking up an independent residence outside the college on the conventional English lodging system.

FIGUREHEAD FROM THE FRANKLIN.

The Passing of the Figurehead.

It is a great exception nowadays to find on the bow of the steamship entering our port the time-honored emblem—the figurehead; in fact, this is but rarely seen even on sailing vessels, and the ship carver's trade is kept alive solely by yacht owners. Years ago, and even back to the time of the earliest ships, the figurehead was considered a necessary part of the vessel, and as much attention was paid to its design as to any other part of the hull. Illustrations of the Roman galleys show clearly what a prominent part this feature of the design held, and later, in the days of the Norsemen, figureheads at the prows of their vessels represented goddesses who were supposed to lead them into victory. On merchant ships it was looked upon as a genius to protect the vessel from storms and disasters.

Up to within a very few years no sailing vessels and but few steamers were without a figurehead, and, where the name of the vessel permitted, this piece of carving was emblematic of the ship's name. Thus the fine old *City of Rome* has under its bowsprit a figure of Julius Cæsar, and the old steamer *Expounder* had a figure of John Marshall holding a copy of the outspread Constitution. The American eagle was always very popular as a figurehead, and it is even now often seen on steamers, not placed at the bow, however, but on the pilot house. The most popular subject, however, was some female figure. Possibly it may be this fact which has caused the gender of a ship generally to be considered as feminine.

The Italians are famous for the bow and stern decorations of their vessels, and the intricacies of the design are no less wonderful than the colors displayed.

In the days of our famous frigates, much attention was given to the figurehead. At the bow of the old *Constitution* was placed a splendid colossal statue of Andrew Jackson. This figurehead and that of the U. S. S. *Franklin* are now preserved at the Annapolis Naval Academy, and, although these carvings were exe-

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cuted fifty or seventy-five years ago and have weathered countless storms, they are still almost perfect. The *Constitution* was launched in 1797, and, according to Soley's history of the Naval Academy, the head of this statue was sawed off and made away with in 1834, and the head which is now preserved was put on the following year. The U. S. S. *Franklin* was launched in 1815. The figurehead bears the painted date, 1853, which was the date when the *Franklin* was razed at the Portsmouth Navy Yard.

It is pleasant to note that the Navy Department is reviving this custom of decorating the bow and stern of our warships. On most of the new vessels a shield and scroll has been placed at the bows, but at present this work is being carried on to a greater extent, and on such vessels as the *Olympia*, *Cincinnati*, and *Massachusetts* are found very handsome pieces of bronze. The decorations of the *Olympia* and *Cincinnati* have already been described in MARINE ENGINEERING.* On the forward turret of the battleship *Massachusetts*, between the two 12-inch guns, is placed a bronze statue of Victory, which was presented to the vessel by the State of Massachusetts.

FIGUREHEAD OF THE STEAM YACHT DREAMER.

However, as above mentioned, it is to the yacht squadrons that one must turn to find the greatest number of figureheads. The one here illustrated is on the steam yacht *Dreamer*. At the stem the body of the figurehead is divided and the design carried along the bulwarks on either side by a well-worked-out scroll. Among the merchant steamers the bowsprit has been entirely done away with, which is doubtless the cause of the disappearance of this ancient emblem.

It is of interest to note that a collection of old figureheads is becoming quite a fad with certain people.

*See MARINE ENGINEERING for December, 1901, and April, 1902.

THE CONSTRUCTION OF MOTOR LAUNCHES.

BY W. F. DURAND.

Within the brief limits of a single chapter only a few general hints can be given regarding the construction of motor boats. While principles are eternal, practice is continually varying, and many of the details of construction will naturally depend on the materials at hand, the skill of the builder, the particular purpose in view, and other special circumstances of the case.

Let us first endeavor to realize clearly the purpose which the builder must constantly hold in view. This purpose, which is twofold, may be stated as the realization of form and the provision of the necessary strength. The first has reference to geometry, the second to mechanics. The design has furnished a form which is to be realized in the actual materials of construction, and with such a distribution of material as shall provide at the same time the needful strength and rigidity of structure. In addition to form and strength, some part of the work of construction will have reference to matters of internal fitting and equipment; matters which relate simply to questions of taste and convenience. These latter are so entirely dependent on taste, and may vary so widely with the special purpose in view, that they may be passed over with the mere mention, and with this understanding we may proceed with the development of our subject under the two heads as noted above.

FORM AND STRENGTH.

While the purpose of the builder is thus twofold, it must by no means be supposed that of the various structural members employed some are used solely for strength and others for form. It is one of the highest purposes of the builder to so arrange his material that, so far as possible, each member may serve a double

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purpose; that it may take its part in determining the graceful form and contour of the boat, and at the same time add its quota to the needful strength. While the aim of the builder is thus to use his material for a double purpose, it will be preferable to consider here the two aspects somewhat separately.

In the first place it may be noted that the actual form is determined by the outer skin or planking. This, however, cannot be realized, the planks cannot be put into shape, without something within over which they may be bent and formed as desired. Even after they are brought into shape, thus forming a hollow shell, they would of themselves scarcely retain their form without some permanent internal framework or stiffening to counteract their own tendency to spring away from the form to which they were adjusted. We have thus begun with the skin because, in a sense, this is the boat itself. All else is secondary and auxiliary. We have seen, therefore, that in order to realize the form something must be provided over which the strips of planking may be bent as required, while to retain it in form something must be provided in the way of internal stiffening and tying members. Now, it is just here that we find two different methods in boat construction. In one, which is quite commonly employed with pulling boats and to a considerable extent in the construction

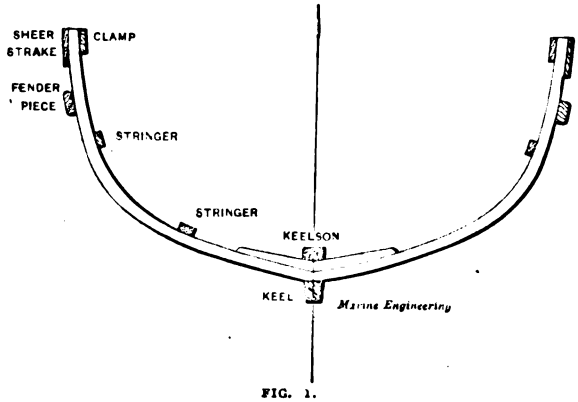

FIG. 1.

of small and moderate-sized motor boats, the forms over which the planking is bent are simply wooden molds put in place temporarily, their sole purpose being to determine the form of the boat. In the second type of construction, which is always used for the larger sizes, the frames and cross ties or deck beams are formed and set up first and the form of the boat is thus determined in skeleton. The planking is then bent to form over the frames and secured to them. In this case, therefore, the forms over which the planking is bent to shape constitute a permanent part of the structure.

We have above referred to the transverse framing as intended to give stiffness and permanency to the form, and such is, indeed, the case, but not alone against the natural tendency of the skin to spring or bend into some other form. It is here that the question of *strength* comes in. Permanency of form and durability of service require sufficient strength to withstand the external forces for which provision should be made, and we are thus led to the second main object of the builder. The skin of the boat, together with a suitable amount of transverse framing to give it permanency, constitute the determination of form, and thus represent the realization of the first main object. At the same time these members go a long way toward giving the needful strength. In fact, the necessity of fitting the spring of the frame against the spring of the planking usually gives sufficient strength in the transverse direction, so that aside from skin and framing the added members are almost entirely those which are needed to complete the necessary longitudinal strength. Without developing this part of the subject from the standpoint of mechanics, it will be sufficient to note that this end is attained by fitting some combination of keel, keelson, sheer strakes, deck and side stringers, clamps, and fender piece. These various members are shown in Fig. 1, though but rarely would they all be found in one design.

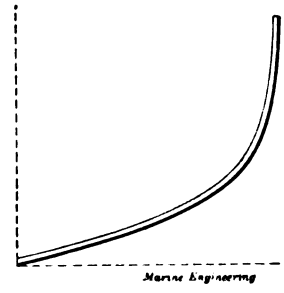

FIG. 2.

To sum up this part of our subject, it appears that form is determined in general by the skin planking together with the transverse framing: transverse strength is provided by the combination of skin planking and transverse framing; longitudinal strength is provided by the combination of the skin planking with the various longitudinal members noted above. Otherwise we note that the skin takes part in the determination of form and in both the transverse and longitudinal strength; the transverse framing takes part in the determination and preservation of form, and in the transverse strength; the various longitudinal members above noted have but slight direct relation to form, and their chief function is to act with the skin in furnishing longitudinal strength. Having thus examined the subject in a general way, and from the standpoint of the functions which the various parts perform, we may consider briefly the principal steps in carrying out the construction along the lines indicated.

LAYING DOWN THE LINES.

The first step in the process of construction is to lay down the lines of the boat, the water lines and sections corresponding to frames and molds, full size on the floor or mold loft. These lines are laid down from the design and are faired up in the same general manner as described in the chapter on design. This gives everything full size and makes possible the ready determination of the dimensions and form of any part of the boat as may be needed.

Reference should be made at this point to the fact that lines as usually laid down relate to the form or the outside of the frames or on the inside of the skin. In such case the lines are immediately available for use in determining the form of molds, frames, etc. In

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some cases, however, lines have been laid down representing the outside of the planking, the actual outer surface of the boat. In such case, after laying down the form of a section for a frame or mold, the thickness of the planking must be taken off all around the outside in order to obtain the actual form for the frame or mold. This operation is indicated in Fig. 2.

MAKING THE MOLDS.

The next step will be making the molds, assuming that the boat is of moderate size and that this system is to be employed. The first question will be as to the number necessary in the given case. Here practice varies widely. Some builders use only three to five molds while others use eight and ten. Not less than five should ordinarily be employed, and in many cases the larger number will be found advantageous. To lay out these molds the form must be determined by transfer from the full-sized midship section referred to above. This transfer may be made most readily by using the heads of small nails. As shown in Fig. 3, the nails are laid down at right angles to the line, with head on the line. They are then struck lightly with a hammer, so as to press the head slightly into the floor and thus hold them in place. In addition to marking out the form of the section in this way, horizontal and vertical lines should be indicated as shown. The board is then laid carefully on the nail heads and pressed down upon them. They will thus be imprinted into the board, and a batten sprung through the points will thus serve to reproduce the form of the section. After making one this is used as a copy for a duplicate, and the pair are then put together and finally finished up, as shown in Fig. 4. Last of all it should be compared directly with the section on the floor, in order to make sure that no error has been made and that it is a true copy of the form of the boat at this point. The remaining molds are, of course, made in the same general manner, and this step in the operation is thus completed.

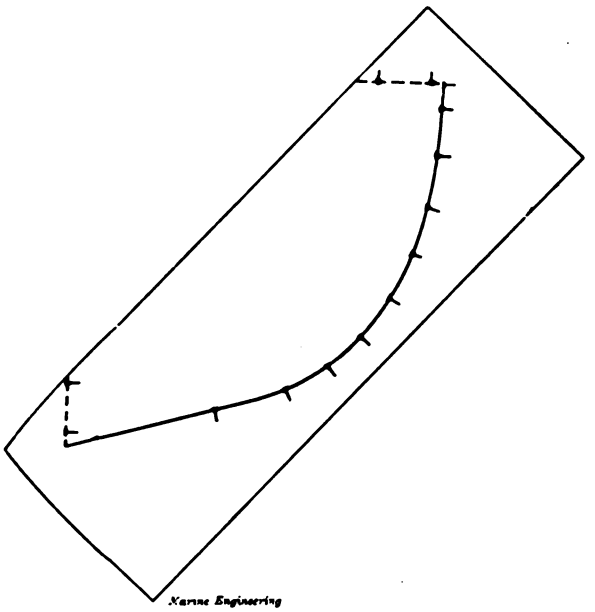

FIG. 3.

We shall next indicate briefly the chief remaining items involved in the work, the order in which the work may be undertaken, and the part which each is to play in the construction as a whole.

METHOD OF CONSTRUCTION.

Keel Support.—This may be of two-inch plank cut to fit the sweep of the keel and blocked up on edge, supported by side braces, so as to furnish a suitable support for the boat and at a convenient height. Care should be taken to so adjust this support that the water line of the boat will be horizontal. This is, of course, no part of the boat proper, and serves simply as a support for the boat while building.

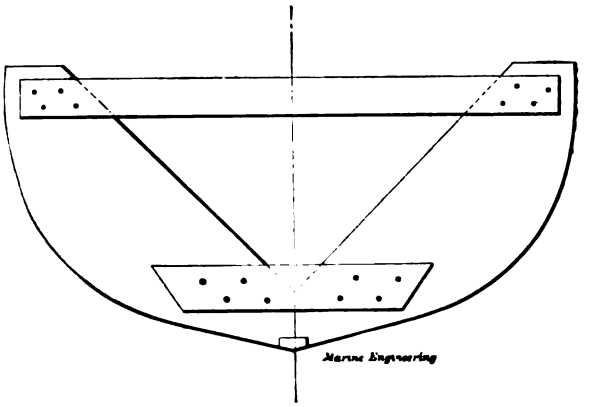

FIG. 4.

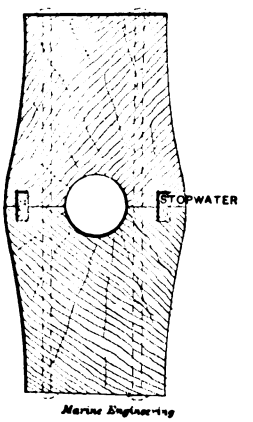

FIG. 5.

Keel, Stem, and Stern Post.—These are usually of white oak and suitably rabbetted to take in the edge of the garboard strakes of planking and the ends at stem and stern. Where a natural crook can be obtained for the stem it should be employed. Chocks should also be fitted in the angle between stem and stern posts and keel, and the whole bolted and secured together as strongly as possible. These various items, after being gotten out separately, may be secured together and erected in place in the keel support referred to above. Figs. 7 and 8 may be referred to as illustrating the relation of these various parts.

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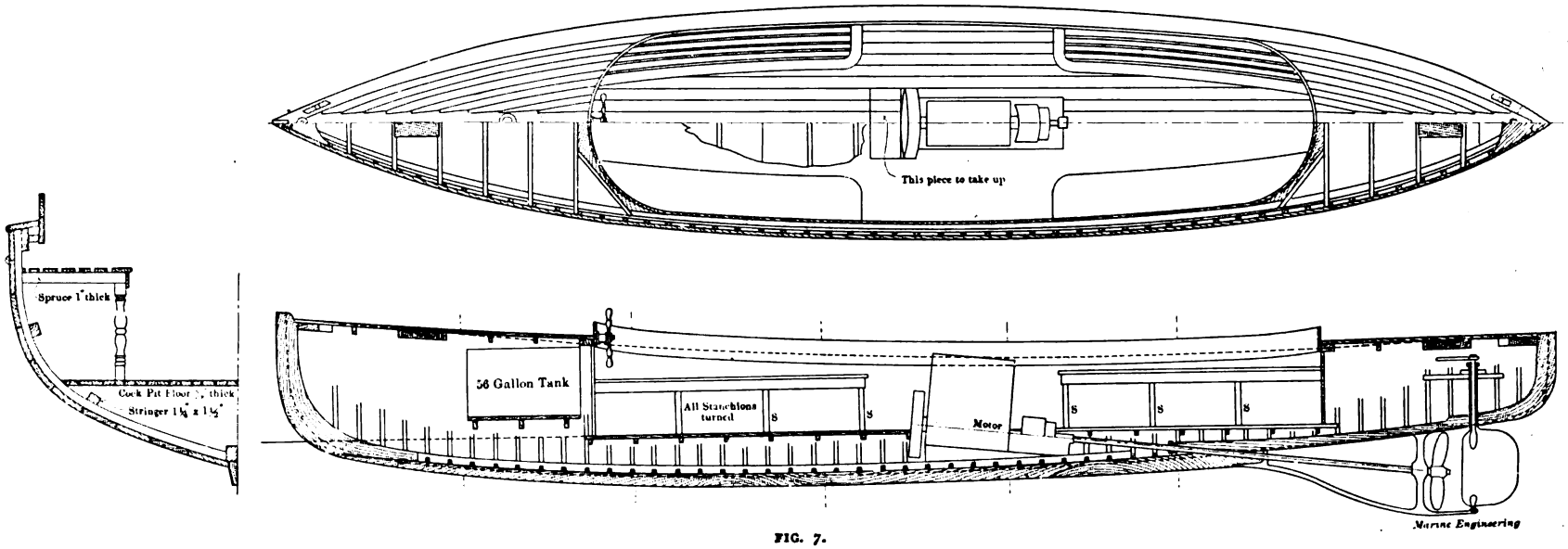

FIG. 7.

Shaft Log.—This is built up on the keel and usually consists of a pair of timbers, as shown in Fig. 5, secured by through bolts, and provided with a hole, as shown, for carrying the stern tube and shaft. The stern post must, of course, be swelled to the same size as the end of the log and provided with the same sized hole. In some types of construction the shaft log is much reduced in length or even omitted entirely. With the flat or torpedo-boat stern, as in Fig. 7, the arrangement will naturally be somewhat different, as indicated by the diagram.

All joints in this fundamental part of the framing should be carefully made with thick white lead and drawn tight with through fastenings where practicable.

Molds.—The molds as previously described may now be set up in place and braced or stiffened so as to retain their relative position. They are centered on the keel by reference to the center line on the mold, and are then lined up by referring the center line on the top of the mold to a cord stretched from stem to stern in the center line of the boat.

Ribbands.—These are strips which are bent over the molds and lightly tacked to them from one end to the other along the planking lines. They serve to further secure the molds in place, and will also indicate any

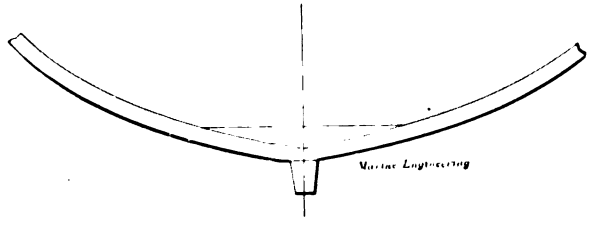

FIG. 6.

unfairness in the form should such exist. The upper ribband should be put on a little above the upper side of the sheer line, so that the sheer strake can go on just below without disturbing the ribband. In small boats, also, the ribbands are readily made heavy enough and the number of molds sufficient so that the frame may be bent directly into place and thus formed without the use of a mold or bending floor.

Frames.—These are usually of white oak, spaced from six to twelve inches or more apart, according to size of boat, and in section from three-fourths inch square upward, according to size and style of construction. The frames should be cut from clear straight-grained stock, air-seasoned and not kiln-dried.

Small frames, as noted above, may be bent directly in place against the ribbands. The frame must first be carefully steamed in a steam box and then taken directly to its place and bent to form. It is then secured to the keel and should be clamped to the ribbands, and finally adjusted carefully in place. For larger construction, and where the frames cannot be readily bent in place in the boat against the ribbands, two methods are available. In one a special mold is cut out around which to bend each frame. In the other a bending floor is used. In preparing to bend the frames by the latter method the form of the section on the inside of the frame is transferred to the bending floor, and then holes are bored and pins

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driven in so that their edges come just on the line of the section. The frame is then heated in the steam box, bent to shape, and then secured by boards nailed across, after which it may be set up in place in the boat.

The frames are centered and adjusted in the same general manner as the molds, and, so far as possible, the entire frame from gunwale to gunwale should be continuous. Where there is any considerable rise of floor, however, or where the sections come to the keel at a considerable angle, as near the bow and stern, this will be impracticable, and the frame will be made in two parts, secured together by nailing a board across before setting up in the boat. The frames must be secured in two ways: to the keel and to the skin or planking. They may be secured to the keel by a floor or chock piece, as shown in Fig. 6. Another method is by similar or by bent floors, and the use of chocks between the frames on the keel and an internal keel or keelson securing the whole together, as shown in Fig. 1.

Planking.—This is usually of pine, cedar, or mahogany. Beginning at the garboard strakes or those next the keel, it is put on one strake at a time, tapering each strake at the ends, so as to carry the same number of strakes all the way fore and aft, and keep the line of planking at the edge smooth and fair. The ribbands are, of course, removed in order to make way for the planking, which is thus gradually brought to form and secured in place. For securing the planking to the frames, copper nails riveted over burrs are accounted the best form of fastening. Next come copper nails turned or clinched over. For cheaper work, however, galvanized wrought nails clinched over have been used with satisfactory results.

After the planking is completed a few temporary cross ties to hold the sides from springing should be fitted, and then the molds may be removed.

Engine Bed.—No special details can be given, as so much will depend on the type of engine to be employed. In general, however, the chief danger is in making it too short or too light. It should be understood that the purpose of the bed is to stand the shock and pound of the engine, and to lead the forces which its motion develops away and distribute them as much as possible over the general structure of the boat, instead of allowing them to be localized at that part directly under the engine itself. The foundation in general should consist of two suitable timbers, preferably notched down over the frames and fitted to the planking. They should be long enough to extend over four or five frames or more, and should be braced transversely and secured through the frames and, perhaps, to cross chocks secured to the keel.

Clamps.—The clamps or rail stringers should be made of oak, seven-eighths to one inch in thickness and two to three inches wide, sprung into place on the inside of the frames at the rail, and securely riveted or bolted through and through. The spaces between the frames may be filled in or left open, as desired. No special increase in strength is gained by filling them in, and if open the boat may be more readily freed from water by tipping on the side. In some cases, however, the rail is finished with a cap piece covering over the upper edge of both sheer strake and clamp, as well as the space between.

Bilge and Side Stringers.—These should be fitted in all first-class construction, as adding to the general strength and stiffness of the boat.

Seats.—The seats, whether transverse or fore and aft, should be supported on the skin of the boat by a suitable stringer piece run on the inside of the frames and secured to them. Chocks or knee pieces should also be fitted to aid in giving racking strength. The seat should be carefully secured to the supporting stringer, not so much for the sake of the seat itself, but in order to constitute it a tie or brace for the side of the boat. Transverse seats thus fitted furnish a very effective internal tie for securing the two sides and preventing spreading, which is often liable to occur in small boats without deck beams or other form of cross tie. If the seat runs fore and aft it should also be securely fastened to the stringer, or, better, between two stringers, one above and one below. This will form a very effective stiffener for the side, and will tend to prevent any change of form after the temporary ties are removed. With fore-and-aft seats the inner edge is, of course, carried on suitable posts or supports extending down and carried on a stringer piece attached to the frames.

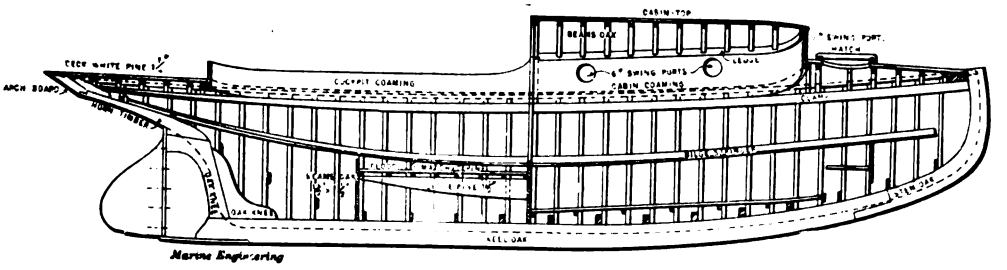

FIG. 8.

Planing and Finishing the Exterior.—After the preceding work is completed, or even before the interior fittings are completed, the outside of the boat may be roughly planed and made ready for calking. The operation of calking the seams is one requiring much skill, and if the services of a professional can be obtained this will be the better plan. If not, the amateur should practice on a few boards nailed together for the purpose. The seam is first opened up a little with a thin chisel, and then the calking cotton is driven in with a thin calking iron. Instead of laying it straight along the seam and then driving it in, a little loop is caught each time, thus greatly increasing the amount of cotton used, as compared with the straight run along the seam. After driving in lightly it is gone over a second time and driven down 3-16 to 1-4 inch below the surface. The seam should then be filled with thick white lead paint put on with a stiff brush. This will soak into the

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cotton and aid in making a water-tight joint. The surface may now be finally planed and smoothed up and made ready for painting and puttying. The plane, the scraper, and sandpaper will all find their use here, and it will be found that slight irregularities will disappear, and if the previous work has been well done the form of the boat will come out smooth, continuous, and pleasing to the eye. The painting may then be proceeded with, care being taken to allow plenty of time for each coat to dry before putting on the next following. Each coat should also be rubbed down somewhat before putting on the next, especially if a smooth and first-class job is desired. Three or four coats will be none too many, and if these are carefully put on the result will be an outer surface smooth, hard, and durable. Below the water line some good marine or anti-fouling paint may be used; while above, good white lead, or a white-lead base with such color as may be desired, may be recommended.

The method of construction thus far chiefly referred to has been that in which molds are employed for giving form to the planking as it is sprung into place, and for retaining the form until the necessary internal ties and stiffeners are provided. With larger boats the frames themselves are necessarily much stiffer and the use of molds for this purpose is no longer necessary. The same general mode of procedure is followed with the simple omission of the molds. The frames are prepared and bent in the same general way, and secured in place as already described. This operation being completed, the boat is "in frame," and the planking and other features are proceeded with along the same general lines as above indicated. In boats of the larger size there will usually be a certain amount of deck, and the deck beams will form an important feature in tying the two sides together and in stiffening them against any tendency to change form.

In these brief hints regarding the actual construction of a boat, the general type held in view has been the usual or older type of stern. The changes in detail in the case of a torpedo form of stern are such as may readily be developed from the general principles referred to in the preceding pages. It will be understood, of course, that there are a vast number of details relating to the actual operations involved which have not been discussed, and in particular is this the case in connection with cutting and fitting the rabbett in keel, stem, and stern post, fitting ends of plank in rabbett, laying out taper or planking so as to keep edges fair and retain the same number of strakes, details of the stern, and the fitting of various attachments and features of the equipment. The intention has been only to give in small space such general hints as may prove suggestive to those who are interested in such work, and who may wish to undertake the construction of a small boat without the full assistance of a professional builder.

There will be many problems of practical fitting and procedure which the builder must struggle with and solve as best he may. If, however, the principles above discussed are held in view, and if a fair amount of mechanical skill is at hand, the results should be a boat at least safe and strong, and, what is perhaps worth still more, the acquirement on the part of the builder of much information regarding boat-building operations which he certainly could in no other wise have obtained.

Damage to the Plates on the Bottom of the U. S. Cruiser Brooklyn.

During the naval war game at the eastern end of Long Island Sound last September quite a sensation was made in the daily papers over the fact that the cruiser *Brooklyn* had struck a rock in Narragansett Bay. The damages were not serious enough, however, to prevent the cruiser from remaining with the squadron, and it was not until several weeks later that the vessel was placed in dry-dock in the Brooklyn Navy Yard. An inspection showed that the plates on the port side, about opposite the forward end of the bilge keel, were badly dented, and that in the wake of these dents the other bottom plates were more or less bent. A few of the plates in the forebody were removed after shoring up the vessel, as shown in the accompanying illustration, and then it was found that several floors were badly bent and had to be replaced.

Bids on the New Cruisers.

On January 6 bids for the contracts of the powerful armored cruisers *Tennessee* and *Washington* were opened and are as follows:

Newport News Shipbuilding Company, one ship, $4,325,000.

Fore River Ship and Engine Building Company, Quincy, Mass., one ship, $4,578,000.

Bath Iron Works, one ship, $4,500,000.

Union Iron Works, of San Francisco, one ship, $4,365,000.

New York Shipbuilding Company, of Camden, N. J., one ship, $4,250,000; two ships, $4,150,000 each.

Same company, on its own designs, providing for 22-knot ships, to be delivered in forty and forty-two months, $4,280,000 each. It was in connection with this bid that the letter was submitted demanding an allowance of 25,000 horse power.

Moran Bros. and Company, of Seattle, one ship, $4,397,000.

William Cramp and Sons, Philadelphia, one ship, $4,200,000.

Same company, on its own designs, ships to be delivered in thirty-six and thirty-nine months and to be of 22 knots speed, one ship for $4,100,000; two ships on same plans for $4,000,000 each.

Same company, on plans of its own, providing for the use of steam turbines and water-tube boilers, $4,100,000 for one and $4,060,000 each for two.

After the bids were opened Messrs. Cramp offered to build both ships on the department's plans for the same figure as given for their own plans. The Board of Construction then recommended that this bid be accepted. An interesting three-cornered contest for the contract has since developed, Messrs. Cramp claiming it because of the Board's recommendation; the New York Shipbuilding Company claiming it because it was the lowest bidder for the two, while the Union Iron Works is urging that the contract be awarded that company because, after deducting 4 per cent. from its bid for one vessel, it is within the lowest bid for one ship. This 4 per cent. deduction was authorized by Congress some years ago on the ground that labor and material cost more on the Pacific coast than in the East.

Owing to the importance of the questions involved, Secretary Moody has referred the papers to Attorney-General Knox for a legal opinion as to the authority of the Secretary of the Navy to accept any modification of plans and specifications after the opening of bids. It is the contention of the New York Shipbuilding Company that the Navy Department cannot permit a bidder to change his bid in any particular after the proposals have been opened, the point being made against the Cramp Company.

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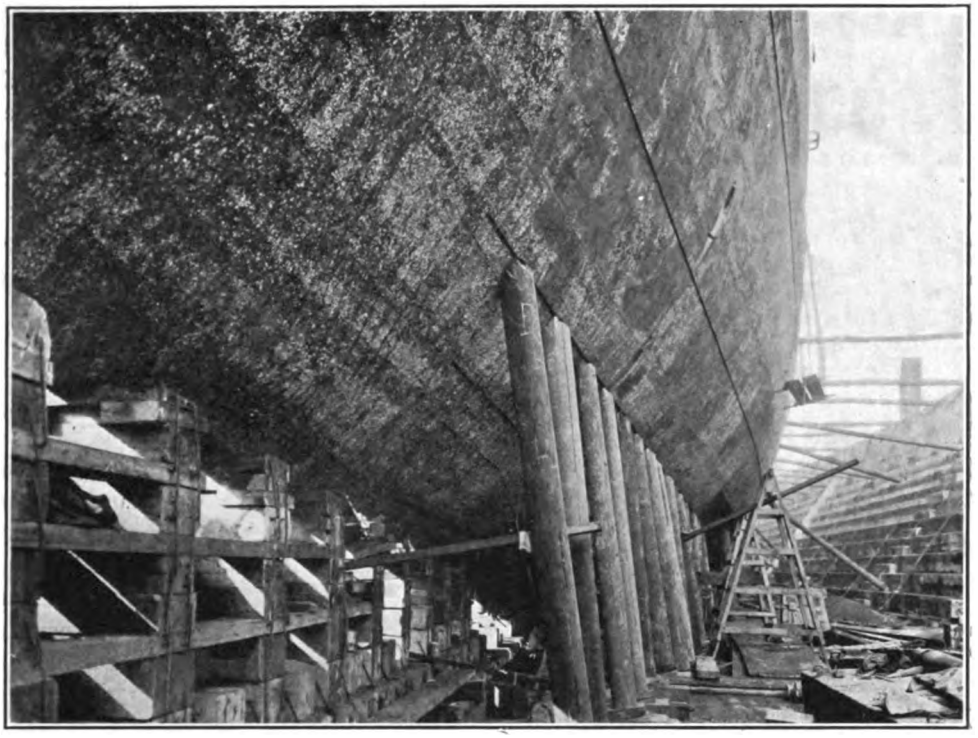
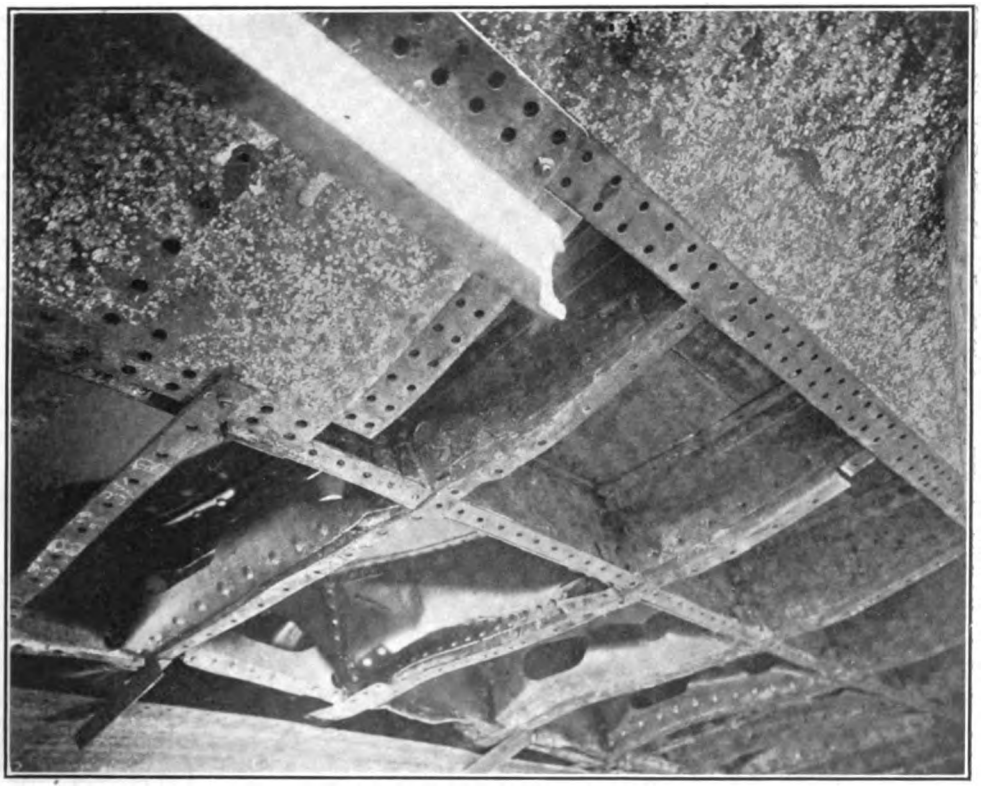


SHORING UNDER DAMAGED BOTTOM OF THE BROOKLYN.



BOTTOM FRAMING UNDER THE UNITED STATES CRUISER BROOKLYN AFTER THE PLATES WERE REMOVED.

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THE field of marine propulsion has long been a favorite with inventors who believe that they have discovered some new and more efficient form of screw propeller or other propulsive device. The principal reasons for this are not hard to find. The interests involved are large and a fortune naturally awaits the man who can displace the screw propeller with something more efficient. Then, again, there is something in a way mysterious about its action, and mysteries are always attractive. Again, it is seemingly simple, a single piece of metal without gear wheels, belts, levers, links, or other complications; it seems attractive in its simplicity and as though any one might safely venture on its improvement. Whatever the reasons in detail, the fact remains and the annual output of new and improved screw propellers or other propulsive devices seems to suffer no decrease. The total number of patents in this field is enormous, and the number still granted each year makes a total which would astonish those not conversant with the facts. It is not our purpose to discourage activity of this character, but simply to note its amount as an interesting fact, and to urge on any who may be inclined to try a hand at improving the screw propeller two or three useful preliminary steps. These are: (1) to become acquainted, so far as possible, with the history of the development of the propeller in its present form; (2) to become acquainted, so far as possible, with the various other types of propeller which have been proposed during this period of development; and (3) to become as conversant as possible with the theory of the propeller in its simpler aspects, and in particular as regards the question of its efficiency under the usual working conditions.

The claims which are so frequently made by those who are concerned in bringing forward freak propellers can only be the result of the most complete ignorance regarding the laws which condition the performance of a propeller, and regarding the fundamental problem of ship propulsion. Thus the inventor or promoter of such propellers will freely claim an increase of speed as compared with the best obtainable by the ordinary form, of from 20 to 50 per cent., or perhaps even more, according as he may happen to make his guess. All this is, of course, absurd. It is well to realize that while the accepted type of screw propeller is far from perfect, and while it is doubtless susceptible of improvement in various ways, still at the most the margin left for gain is relatively small. A few facts will make this clear. Propellers of the usual type and operating under fairly suitable conditions have an efficiency of from about 66 to 70 per cent. If this 30 to 34 per cent. which is not directly used for propulsion could be so utilized, the speed would be increased by about 15 per cent. This is the entire margin so far as speed is concerned. But may not some inventor devise a propeller which will realize the entire margin, moderate though it may be in comparison with the larger figures quoted above? Yes, we may answer, on the same day on which he lifts himself over a fence with his boot straps.

There are some things which we cannot do, at least so long as the laws of mechanics remain as they now are. We cannot propel a ship without setting in motion sternward a column of water from which to derive the propulsive thrust. No matter how perfect or ideal the propeller may be, no matter how completely we may be able to avoid the losses due to friction, to the formation of eddies, to rotation and to various items which in the usual propeller are believed to give rise to losses of energy, the expenditure necessary to develop the sternward motion in the column of

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water acted on will always exist. While the extent of the loss will vary somewhat, it can scarcely be made much less than 20 per cent., or, in other words, if all other sources of loss were avoided the maximum efficiency would be not far from 80 per cent. Since these sources of loss relate to the form of propeller, size, shape, and surface of blades, etc., it may be fairly said that mechanically this 10 to 14 per cent., lying between the actual and ideal efficiencies, represents the actual margin which the inventor has before him in the attempt to improve the present type of propeller. Could he compass the saving of this entire margin, the increase in speed would be about 6 per cent. This, then, is the full possible margin, and it is very sure that no form of propeller acting directly on the water will ever be able, with the same power, to effect a greater increase in speed than some such margin, as compared with the speed given by a suitable propeller of the usual form. Improvements in speed greater than this have, of course, been reported as the result of a change in propellers. In such cases, however, the presumption is that the first form was not suitable and hence inefficient. The only fair comparison is when each form is allowed to do its best, and with this understanding there is no possibility with the same power of an increase in speed greater than close about the 6 per cent. mentioned above, and practically there is no possibility of this without some change in the laws of liquid friction, formation of eddies, etc. The field, however, is open, and all interested will welcome such improvements as may come, small though they may be in comparison with the visions of those whose enthusiasm in such matters is not ballasted with a knowledge of the fundamental facts in the case.

THERE seems to be nothing in either the size or speed of the new Cunard steamers looking toward an indication of a limit in such matters. The advance during the past fifteen years—the period covered by the modern twin-screw Atlantic greyhound—has been continuous in both size and speed from the 525 feet, 14,000 tons displacement, and 20 knot speed of the former *Paris* and *New York* to the 720 feet, 30,000 tons displacement, and 25 knots of the present designs. Throughout this history the advance has been conditioned on one inexorable law, that advance in speed can only be obtained by increase in size. This presupposes, of course, a generally similar type of construction, and a similar relation between the power and the weight required for its development. This has in the main been fulfilled. While much advance in detail has been made, and while water-tube boilers and the possibilities of turbine engines seem to promise substantial advances in power per ton of weight, still the gain thus far assured has been only moderate, and by no means sufficient to compensate for the requirement of added size. In short, torpedo-boat construction is a type not fitted to mercantile conditions nor to large-sized ships; and while the present size of a boat necessary to maintain a speed of 25 knots is somewhat less than if the engineering conditions of the *Paris* or *Teutonic* were exactly reproduced, still the gain has not been sufficient to make possible any great advance on the same size. It is perhaps doubtful if otherwise the sizes of the Atlantic express steamers would have been increased in anything approaching the same proportion. It is true that large size has some advantage in itself, and that the past few years have witnessed a marked increase of size in the moderate speed freight steamer, where cargo capacity and not speed was the prime requisite, and where the increase in size was the result of a demand for more capacity rather than for higher speed. Here still, however, the same general law has its effect, and the large freighter gains its advantage by carrying a ton of freight at a lower cost per mile than the smaller boat.

The point of this is that the progress in the future will be conditioned on the same general laws, and that further increase in speed will require either a pronounced change in the relation between power and weight or still further advances in size. Regarding the former, oil fuel, the water-tube boiler, and the steam turbine form our chief hopes, but the extent to which they may be able to furnish increased speed with the same size, or the same speed with reduced size, can only be determined by the experiment on a full-sized scale. Regarding the increase in size, the difficulties to be met with are more likely to be those relating to harbor and docking facilities than those of shipbuilding itself. Constructively a ship 1,000 feet long might undoubtedly be built, if desired, and probably with less difficulty than that met with in berthing, handling, and caring for her after her completion. The demand of the age, however, seems to be for reduced time and higher speeds, and this demand will undoubtedly be met in one way if not in another. For the detailed route we must await developments of the coming decades.

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Troubles with Piston Rings.

Editor Marine Engineering:

Having been shipmates for the past four and one-half years with a peculiar set of engines, and one that varies considerably from the ordinary, I thought that a partial description of them, of the ills they were heir to and some of the remedies that were applied, would be of interest to your readers. The engines, driving twin screws, are inverted, direct-acting, three-cylinder, triple-expansion, with cylinders 31 1-8, 46, and 70 inches by 30 inches stroke. Each engine is worked from outboard; the air pump, being back of the go-ahead guide of the L.P. cylinder, is driven direct from the piston by a rod extending down through the bottom of the lower head of the L.P. cylinder. The circulators are of the independent centrifugal type. The main condensers are between the L.P. cylinders and the fore-and-aft bulkhead between the engine rooms, and connect to the L.P. cylinders by a short copper expansion joint. The H.P. valves are of the piston type, while the I.P. and L.P. are of the double B type, with four steam ports and single exhaust port. These engines are very short connected, the main-bearing caps being flush with the floor plates, while the bottom of the L.P. cylinders is only 5 feet 5 inches above the floor plates. This necessarily brings about very short eccentric rods and a very erratic valve motion, the radius of the links being only 4 feet 4 inches, while they are about 4 inches square and 4 feet long, of the solid-bar type.

I was detailed to this ship on April 26, 1898, and we sailed before having a chance to examine the machinery. From the start the engines worked very unsatisfactorily; they backed badly, the links of the I.P. and L.P. "slotting" nearly 8 inches in the back motion. The pistons were apparently traveling all over the cylinders, and top and bottom end pins and main bearings thumped like modern steam hammers. After being constantly under steam from about May 3 till the latter part of August, we then had a chance to open cylinders for examination.

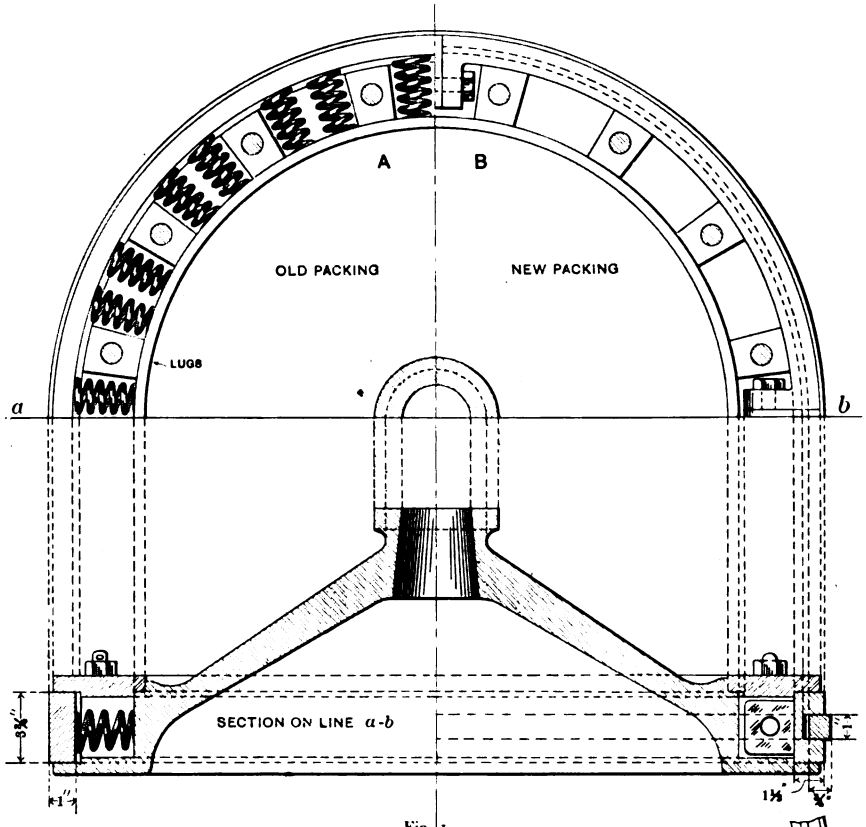

Fig. 1.

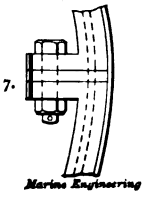

Fig. 7.

The pistons of all cylinders were fitted with rings and springs, as shown in the quarter of sketch marked *A*, Fig. 1. The springs were hurriedly removed and packing rings lifted, cleaned, and replaced. At this time it was observed that the pistons were nearly a half inch less in diameter than the bore of the liners, which of course threw the work of steadying and guiding the piston entirely upon the rings and springs. The rings showed very badly on the wearing face and had a dragged dull surface, due to excessive wear and friction. The liners

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were of a very hard, close-grained iron, not in the least scored or cut, and were from all appearances a good job. From time to time the question of fitting new rings of a different type was brought up, but not acted upon.

We left New York on October 20, 1899, and started our run of 13,000 miles for Manila. Up to the time we arrived at Colombo, Ceylon, we had made three stops for coal, and at each stop we examined and cleaned cylinders, oiled them, and tried follower bolts. The first night out from Colombo eight of the follower bolts of the port H.P. piston let go without any warning. After a bump or two the engine was stopped, the bull's

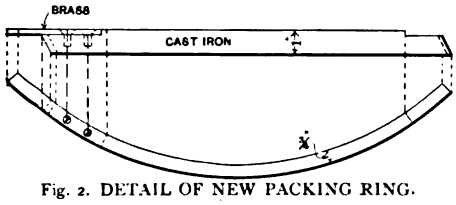


Fig. 2. DETAIL OF NEW PACKING RING.

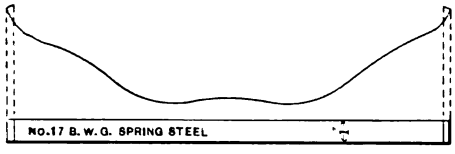
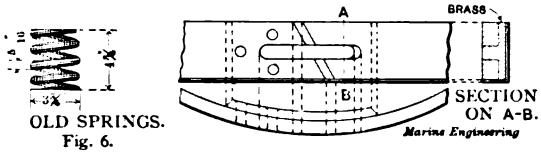


Fig. 3. NEW RING SPRING.



OLD SPRINGS. Fig. 6.

Fig. 4. OLD PACKING RING JOINT.

eye in cylinder cover removed, and the cause of the bump discovered by the missing follower bolts. We at once removed the cylinder cover and found that the bolts had let go at the square, where they were screwed into the piston lugs. Twenty-eight pieces of the steel bolts and nuts were found on top of the cylinder liner and carefully matched together; then it was found that one nut and one and one-half studs were still missing. On removing the bottom relief valve of the H.P. cylinder the missing pieces of the stud and one-half of the nut were fished out with a wire from lower steam port. This left only one-half of a 1-inch bronze nut missing, and this was finally found in the steam-chest drain of the I.P. engine. Our port engine was stopped about 24 hours to drill out eight 1-inch steel studs, make eight new ones, get them in place and secure. Frequent examinations after this showed all of the cylinder rings to be wearing excessively and not in any way improving the wearing surface of the liners.

While in Nagasaki, Japan, in March, 1900, having some other work done, it was decided to replace both H.P. piston rings with new ones of the same type as the old ones, it being thought at this time that the iron in the rings was too hard. By actual measurement the rings were found to stand open on the tongue piece (see Fig. 4) about 1 3-8 inches. A new set of H.P. rings were fitted and left open 1-32 inch, and we started on our return voyage to Manila. The second day out the piston rods and valve stems on both sets of H.P. and I.P. engines were beginning to cut, and as the packing (Duval's braided wire) on all these rods had not been changed for a number of runs, aggregating about 20,000 miles, the trouble was attributed to the cutting of the new H.P. rings. On first leaving Nagasaki, with the engines turning about 80 revolutions, a constant clattering noise began in the H.P. cylinders, and on the second day out it became worse and fully equaled a boiler shop or a Chinese band. A little cylinder oil used in the H.P. cylinders somewhat deadened the noise, but did not stop it altogether. On our arrival at Manila the cylinders were examined and the H.P. liners found to be in fair condition, but on lifting the followers the new rings were found to stand open 1 5-8 inches. We then took out every other spring to lessen the friction, and fitted another set of new rings which we kept for spare.

The ship then cruised for about six weeks along the northern coast of Luzon. The weather continued fair and we called at several ports, sometimes two a day, but always were under steam. On returning to Manila the rings were thoroughly examined and found to be no better and not much worse. We sailed again on August 15, 1900, for Woo Sung, China, and for six days were in a typhoon on the China Sea, the ship rolling heavily. As many of the springs in the H.P. cylinders had been removed, the rolling movement caused a bad side slap of the pistons and reminded us that we had removed too much of the spring load from the packing rings. While lying in the river at Woo Sung and afterward for a couple of months off Taku, the question of a new design of packing ring came up. It was found that the H.P. cylinder cover might be removed, the follower and packing ring taken out and replaced and secured in about eight or nine hours. So this became a very easy problem. We designed a single solid ring of the same dimensions as the old ring, except we turned the ring to fit the bore of the liner and bored it to fit over the piston lugs, so as to remove all slack between the cylinder walls and the piston. Into this bull ring a groove was turned to take a ramsbottom ring 1 inch wide and 3-4 inch thick.

That finished the H.P., but the I.P. and the L.P. were a far different problem, because of the scant space between the protective deck and the top cylinder covers, the distance in the clear being 12 inches for the H.P., 10 1-2 inches for the I.P., and only 8 inches for the L.P., as shown in Fig. 5. From the shape of the L.P. heads it was found barely possible to remove the old packing ring and follower, even by removing the balance piston and cylinder of the L.P. valve, and it was estimated the work of removing and securing would occupy about three days. The I.P. would require for the same work about two days. This was entirely too long a time to disable the engines, as many of the harbors on our station had poor protection and poor holding ground. Therefore scale drawings were made for a sectional ring for the I.P. and L.P. engines, to combine all of the good features of a solid ring, so as to steady the pistons, and to carry a packing ring for the sole purpose of making them steam-tight without the excessive friction of the old rings. In Fig. 1 I have shown in the sketch, which is not to scale, a quarter section of the old and new packing rings, both in plan and cross section. By referring to section *A* of the old packing and springs it will be seen how the strain of

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steadying the piston was thrown on the ring and springs. In section *B* of the new rings is shown how the space between the cylinder walls and the piston lugs is taken up by the new bull ring and the piston kept central. In this sketch I have shown the packing ring forced out by the spring as it would be before putting in the cylinder. When the packing ring is in place in the cylinder it only projects about 1-64 inch outside of bull ring. By making the new bull ring, packing ring, and springs sectional it was found that by swinging the followers in the top of the cylinders the packing ring could be raised and blocked up above the piston, then unbolted and the sections passed out through the bull's eye in the top cylinder cover, and then cleaned, replaced, and secured in less than eight hours. This was of course a great improvement over any kind of ring that would necessitate the removal of the cylinder heads.

The new bull rings were made a trifle fuller in depth than the old rings, so that the follower would "nip" the ring solidly, and the piston thus have all of the advantages of a solid piston. We had the new rings made in Shanghai, and when they were ready we cut the old rings in three pieces and passed them out through the bull's eyes. The new rings, properly marked, were then passed in by sections, the distance pieces fitted, bolted up, and then dropped into place. As the new ring had to be bolted up on blocking, the distance pieces became a necessity, so that the last section could be shoved out against the cylinder walls squarely. The distance pieces thus crowded all of the rings together, so as to allow more space for the last ring to be put in place. The lugs on the new sectional ring were spaced so as to drop into the pockets in the piston that were occupied by the old springs. These lugs and distance pieces are shown in the ring detail, Fig. 7. The bolts in the lugs were turned and the holes in the lugs and distance pieces reamed, thus making a good fit. Fig. 2 shows a section of the new packing ring as fitted, there being six sections in the L.P. and only three in the I.P.

The springs as fitted are shown in Fig. 3 and are made from spring steel 1 inch wide and slightly corrugated to give the proper spring. The ends of the springs were turned up slightly on each end, so as to prevent the springs riding or slipping by each other.

The old spiral springs, Fig. 6, were compressed 5-8 inch, and with 32 in the L.P., 24 in the I.P., and 16 in the H.P., it will readily be seen that the friction load on the old rings was enormous. By actual weighing, the load required to compress each spring 5-8 inch was found to average about 50 pounds for each spring. This would give $32 \times 50 = 1{,}600$ pounds for the L.P., $24 \times 50 = 1{,}200$ pounds for the I.P., and $16 \times 50 = 800$ pounds for the H.P., which, divided by the square inches of bearing surface, is about 2 pounds for the L.P., 2.2 pounds for the I.P., and 2.4 pounds for the H.P. per square inch of bearing surface. The friction load of the new spring was less than .2 pound per square inch of bearing surface. It can be seen that at a maximum speed of 157 revolutions and a piston speed of 785 feet per minute, the unusual wear on the old rings would be easily accounted for. Since installing the new rings and springs, over twenty months ago, this ship has steamed a good many thousand miles at all speeds. The rings have been taken out and examined regularly every three months, and have always been found to be in perfect condition; the cylinders and the rings are beginning to show a very fine polish.

I have seen this ship with the old rings and springs make 90 revolutions with both engines on two of the main boilers, but this was pushing her very hard, while with the new rings and springs we averaged 99 revolutions from Nagasaki to Manila on two boilers.

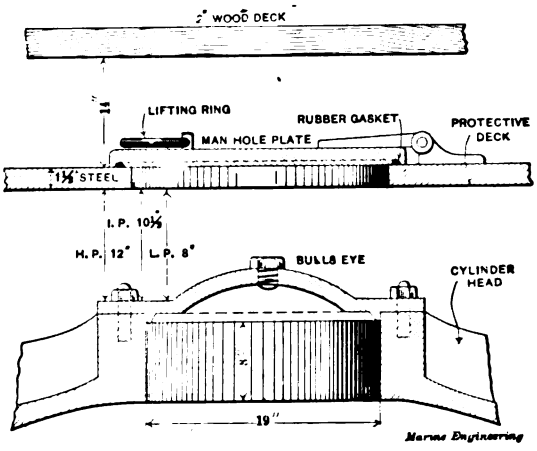

Fig. 5. SECTION THROUGH BERTH DECK, PROTECTIVE DECK & CYLINDER HEAD.

The cylinders are opened, cleaned, and wiped out with a little cylinder oil after each run. Other than this, no cylinder oil is used whatever. The principal dimensions of the ship are:

Length on water line	346 ft. 0 in.
Beam, extreme	43 " 9 "
Mean draft	18 " 0 "
Corresponding displacement	3,769 tons
I.H.P.	7,500
Propellers	2
Diameter	12 ft. 0 in.
Pitch	15 " 9 "
Boilers	4 double-end Scotch
Diameter (mean)	12 ft. 1 in.
Length	17 " 10 "
Furnaces	Three in each end
G. S., each boiler	120 sq. ft.
H. S.	3,594.5 " "

A. E. B., U.S.N.

Securing the Brass Seat in Steam Stop Valves.

In the repairs to ship machinery I have often noted that the seat rings of large cast-iron or cast-steel steam stop valves are secured as shown in Fig. 1. The lower part is cylindrical and fits firmly into the metal of the casing. Extending from the valve seat is a flange *F*, as shown, which serves to secure it to the casing, a red-lead joint being fitted under the flange so as to prevent all possible leakage

This practice is open to some objections. Thus, to put the valve-seat ring in place it must be passed through the upper opening *A* in the casing. In consequence of the seat-ring flange, we must make this opening much larger than would serve for admitting the valve, and thus the diameter of the cover is unnecessarily increased, with corresponding increase in the number or size of the studs necessary to secure it to the

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casing. The necessary drilling and tapping required for the seat studs is also rather difficult and adds to the cost.

A somewhat different system, which has given excellent satisfaction, is shown in Fig. 2. The valve-seat ring is made slightly tapering and fits into a corresponding bed in the casing. The diameter *B* is not more

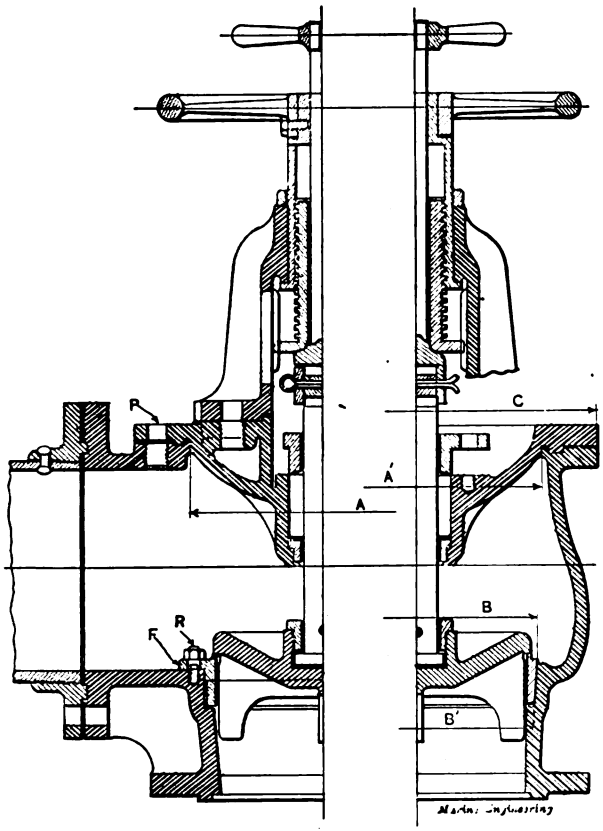


FIG. 1. FIG. 2.

than 3-64 inch greater than the diameter B^1, such taper being found suitable for the purpose. With this arrangement also the ring may be tried in place and adjusted before being finally forced home. For the latter purpose a strong back and bolt may be used, as in Fig. 3.

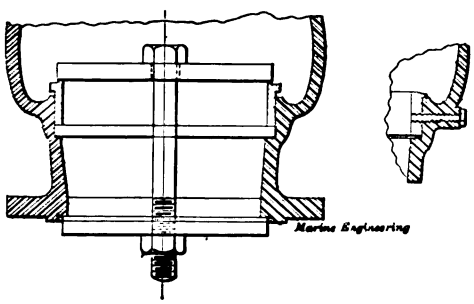


FIG. 3.

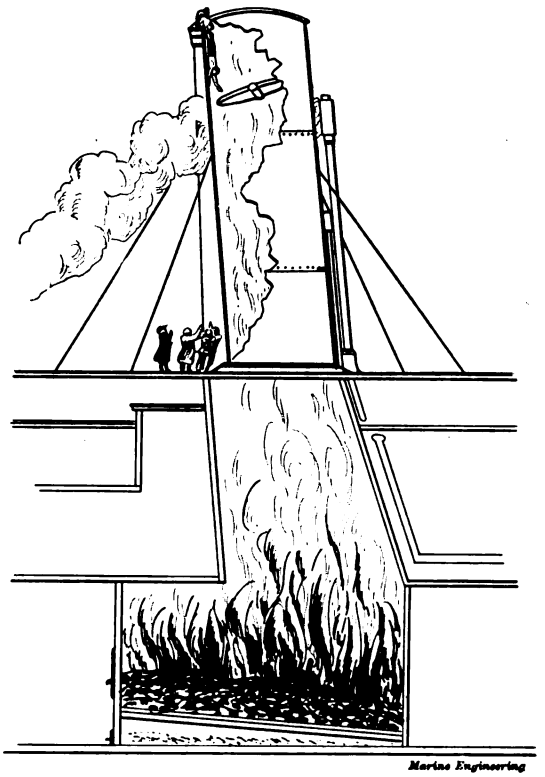
This manner of securing the seat ring in a cast-iron or cast-steel valve casing is evidently secure, for, due to its conical form, it will act as a wedge, and when tightly forced home will remain fixed without other means of fastening. It is also economical of space, for the flange *F*, Fig. 1, is not required and the work of fitting the studs *R* is also saved. The opening of A^1 in the casing, Fig. 2, can also be made less than *A*, Fig. 1, and thus a general saving is effected on the cover and its fastenings. For final security, if desired, the seat ring may be locked by a simple screw, as shown in Fig 3.

D. ATTILIO.

The Boiler from a Reporter's Point of View.

Herewith is produced from one of the New York dailies a remarkable sketch illustrating the brave act of an engineer on board the steamer *La Champagne*. From the paper's account we cull the following details:

The latch securing the damper in the after funnel became unfastened and the damper closed, thereby shutting off the draft to half the battery of boilers. An oiler who was ordered to the top of the stack to see what



BOILER REPORTED TO BE ON STEAMSHIP.

was the trouble was overcome with the gases and hung balanced on the rim of the funnel. An engineer named Pommier then climbed to the top and brought down the unconscious man. Pommier again ascended the stack and, while a seaman grasped his ankles, lowered himself head-first down the inside of the funnel and replaced the latch on the damper.

The point of interest to our readers will, no doubt, be the section of the "boiler" and uptakes. The boiler should evidently be classed as the fire-tube type, as there is nothing to indicate the presence of water in tubes or cylinders, or anything of that kind. In fact, the outfit looks more like a retort. The sketch is subject for thought. Ridiculous as it is, it illustrates how absolutely ignorant the general public is of all classes of machinery.

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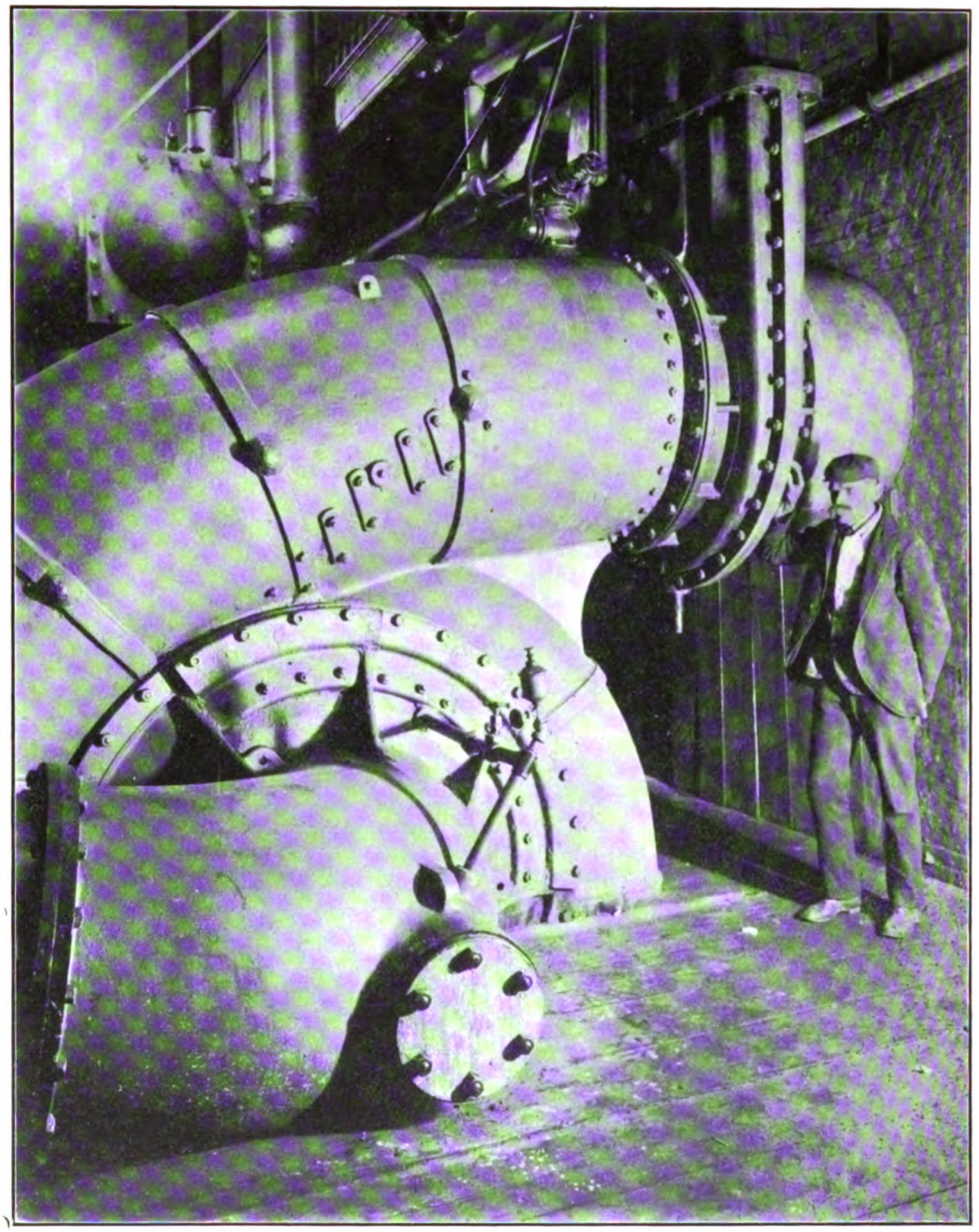
ENGINEERING SPECIALTIES.

Smooth-On Iron Cement.

Many breakdowns incidental to machinery subjected to steam and hydraulic pressure can be successfully repaired by use of the material known to engineers as Smooth-On iron cement. The uses of this material in repairs are numerous, and one of these, shown in the engraving, is of the repairs to a large centrifugal pump in a dry-dock pumping station, Brooklyn Navy Yard.

The pump and 48-inch discharge pipe split almost in two about four years ago, due to a sudden strain, the crack extending for about 20 feet and in some places opening up to three-quarters of an inch. To replace the pump with a new one would have required many months, and the dry-dock could not have been operated without the pump. It was decided to use Smooth-On, and within three days after the breakdown the pump was running, and continued successfully in service for thirteen months, when it was replaced by a new one. The second pump broke in about the same place one and a half years ago, and it in turn was repaired with this iron cement, as shown in the cut, and from that day to this has not given any trouble.



CENTRIFUGAL PUMP, BROOKLYN NAVY YARD, REPAIRED WITH SMOOTH-ON.

Smooth-On is a metal cement, which, properly mixed with water, metalizes and expands. The method of making the repairs consisted in fitting a patch on the inside of the fractured pipe. The metal under the patch and in the seam was covered with a thin layer of the

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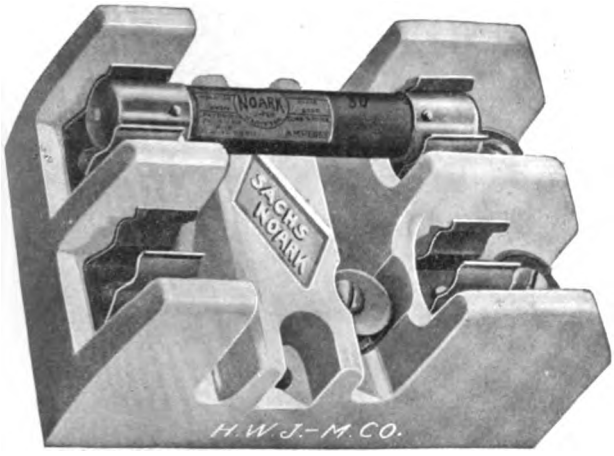
iron cement, and the patch was secured by bolts, as shown in the engraving. Repairs to the housing were made by fitting a patch on the outside, cutting the two surfaces of the metal, and then drawing up the patch with bolts, as shown. Three years ago the suction pipe of this pump broke in two under the ground, due to settling, and this break was repaired with this iron cement and has given good service ever since, showing the practical use of the material when applied by skilled engineers. This iron cement is made by the Smooth-On Manufacturing Company, of Jersey City, N. J.

Branch Fuse Blocks.

To meet the demand for enclosed fuse branch blocks, the H. W. Johns-Manville Company, 100 William street, New York, has placed on the market a line of single branch blocks, one of which is herewith illustrated. A departure has been made from the usual arrangement of branch block devices in which fuses for the branch sockets abut at right angles to the outside of the two or three parallel main wires. This construction requires a block of some size, owing to the fact that it is necessary to give space for the main wires and branch fuses separately. In the "Noark" branch blocks the object



BRANCH FUSE BLOCK.

has been to economize space and at the same time produce a branch block in which the arrangement of the wires and fuses should be absolutely safe, both in the operation and manipulation of the device. To obtain this result the branch fuses are so arranged that each of the terminals in which the branch fuses are received and to which the branch wires are connected are separated from the adjoining terminals by heavy partition walls, high enough above the contacts to prevent anything being laid across from contact to contact and cause short-circuiting. This feature is also predominant in the main blocks. The main wires to which the branch block is connected, instead of passing across the block at the end of the branch fuses, are arranged to traverse it in suitable grooves placed in the porcelain block between the terminals of the branch fuses. In this way a great economy of space is effected, while at the same time the block can be easily and readily installed and the manipulation of the fuse devices for a removal or insertion is entirely safe.

One-Snap Air Port.

An air port has recently been placed on the market, manufactured by the Delaware Marine Supply Manufacturing Company, Incorporated, of Wilmington, Del., which embodies several new features of design and has overcome the objections met with in making a water-tight, quickly-operated air port. The special features of this air port are: that the glass and deadplate are each closed by one operation by an eccentric snap and the pressure is evenly applied to all parts of the rubber filler in the rings. All the material is brass, and the ring itself has a faced surface on which the rubber bears. The glass is carried in threaded male and female rings, which, when tightened up, compress the putty into all open space, acting as a stuffing box and making the

NEW DESIGNED AIR PORT.

joint absolutely water-tight. This ring is carried by a loose hinged band which is in contact with the ring at two points diametrically opposite to it. Each side of the ring has a rubber filler. To close the air port the glass supported in the band is swung down and the eccentric snap, which catches on the band, is turned. This snap will at all times give the same pressure for closing the port, but may be adjusted to take up any wear. There is, therefore, no danger of the ring being sprung or the glass broken, as when dogs are used.

The deadplate has a hinge at right angles to that of the glass and is supported at the center by a yoke. A similar eccentric snap catches the yoke and brings the deadplate down upon the rubber ring with an equal pressure at all points.

These air ports, which are made in different sizes and finish, are well designed throughout and specially adapted for passenger steamers and yachts. This principle of making the glass and ring water-tight is carried out in all the air ports and deck lights made by this company.

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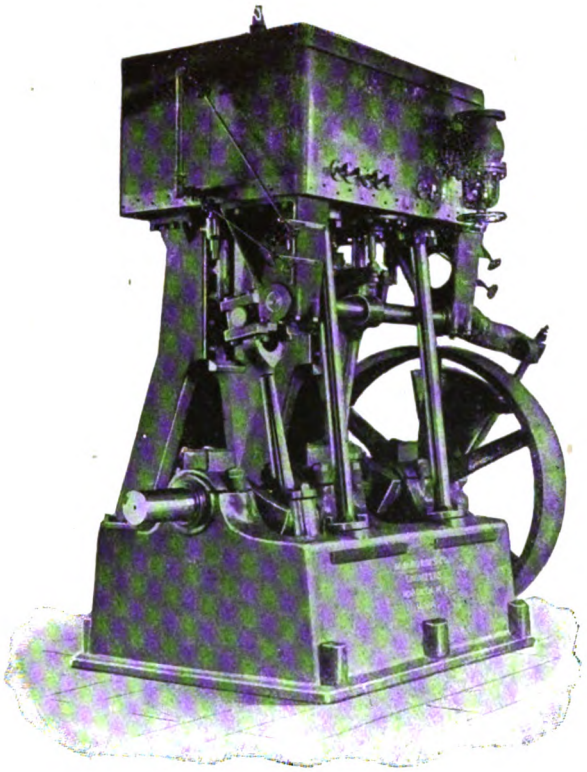
New Compound High-Speed Engine.

To meet the demand for engines of larger capacity than those heretofore made, but of the same quality of workmanship and general design, the W. D. Forbes Company, Hoboken, N. J., has produced an engine, herewith illustrated.

The cylinders are 14 and 28 inches diameter, with a stroke of 16 inches, and the revolutions per minute will be between 250 and 300. Both high and low pressure cylinders are fitted with piston valves, one controlling the steam on the high pressure, and two on the low pressure cylinder. The valves are of the usual plug style made by this company and work in liners with machined ports. These valves are actuated by a rocker shaft,



HIGH-SPEED COMPOUND ENGINE.

which is supported on brackets, as shown. The governing is done by a Rites automatic governor, which is too well known to require any description, except to say that the governing of these engines is sufficiently close to satisfy the conditions of running generators in parallel for alternating-current machines.

The crank shaft is made from a solid steel forging, and the connecting rods are of the torpedo-boat style, the lower ends being fitted with bronze bushings, while the upper or forged end is fitted with the marine style of brasses. The crosshead is forged from the solid and fitted with a bronze shoe; piston rods are fitted to the pistons and the crossheads with tapers; the pistons have double rings, and the low pressure is fitted with a follower. The usual relief valves are placed on top and bottom of the cylinders, and the oiling system, which does not show in the illustration, is ample, oil being fed from large cups to the various parts of the engine, sight feeds being conveniently placed so that they can be readily seen and adjusted. The main bearings are provided with bronze shells or bushings.

Great care has been exercised throughout in the selection of material. Although the engine shown was gotten up for electric-light work, it can, of course, be used for general shop drive and for many purposes, such as driving centrifugal pumps, large blowers, etc.

New Method for Coppering Ships.

The Coleman Ship Coppering Company, of Boston, Mass., has been recently incorporated to exploit certain patents which cover various processes for coating with pure copper the hulls of vessels and other structures, either of wood, iron, or steel, for the purpose of preventing corrosion, fouling due to vegetable or animal growths, or, as in the case of piles, their destruction due to the ravages of the teredos.

COATING A SHIP'S BOTTOM WITH COPPER SPRAY.

The process consists, briefly, in covering wood or steel with a matrix paint, into which is blown, under air pressure, finely divided pure copper, thus obtaining a smooth and durable metallic surface at much less cost than where sheet copper or yellow metal is used for the purpose.

In case of iron or steel a layer of fine quartz embedded in a matrix is interposed, as an insulator, between that metal and the copper coating, which is found after exhaustive tests to absolutely prevent any electrolysis or pitting of the steel plates.

Professor Elihu Thompson recently made several careful tests to determine if electric contact was established between the copper and the iron of the coated plate when the plate was subjected to violent abrasion by glancing and direct blows of a hammer and by forcibly driving the plate between vise jaws. There were no indications of electric contact, even though an 110-volt current was used for testing.

The special advantages of this process to yachts and small vessels are the uniform smoothness and durability

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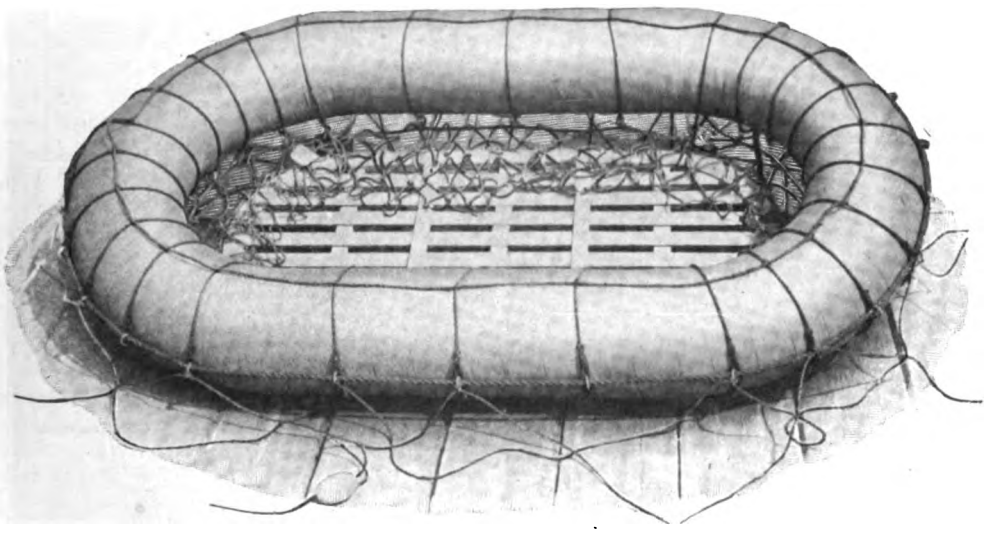
of the surface, the absence of fouling, and the preservation of the hull, rendering frequent hauling out unnecessary. This coating should last at least two years without renewal, and if, for any reason, the vessel's hull be damaged, the surface may be easily and quickly repaired by the aid of portable apparatus supplied by the company. Many vessels have already been coppered by this process with very satisfactory results to the owners.

There are many other important uses to which this process may be advantageously applied. Wooden piles exposed to the attacks of the teredos and marine insects may be copper coated and preserved indefinitely, whereas now their destruction is rapid and large sums of money are expended yearly in replacing them. Structures of iron or steel for various purposes may be copper surfaced at little cost and fully protected from corrosion due to dampness or action of sea water.

Excellent facilities for coppering vessels of any tonnage are secured in New York, Boston, and New Orleans, and further detailed information will be furnished on application at the offices of the company, Devonshire Building, Boston, Mass.



LIFE-SAVING BOAT.

A New Life-Saving Device.

Many inventions have been brought out for increasing the safety of life at sea, but the one herewith illustrated has features which recommend it to this class of work. It is claimed that the Carley life float, as it is called, is non-sinkable, non-collapsible, non-capsizable, and is always right side up, no matter how it may be thrown overboard.

The device consists of a continuous copper tube with many air-tight compartments strengthened by flanges or fins. This tube is covered in turn by two inches of compressed cork and wound with canvas, the whole being treated with a special water-proof, non-corrosive paint, in order to be absolutely water-proof. Attached to this cylinder is a rope netting three feet deep, from which is suspended, by rings which travel on lashings, the slatted wooden bottom. The float is constructed in such a manner that, no matter which side of it may fall upon the water, the bottom drops through and is in its proper relation to the buoyant cylinder. Oars and signal flags are lashed to the sides, while a breaker of water and boxes of food can be lashed to the tube. The shipwrecked persons stow themselves inside this elliptical device and are not atop of a wave-swept surface to which they must cling and devote every energy to keep from being washed away. Their haven is an absolutely safe refuge, from which they can eventually be rescued.

Extreme lightness is a feature of the device. Two men can toss the largest size, which weighs 525 pounds and is capable of sustaining forty-five persons. over the bulwarks of a ship. The Carley float alone possesses, in addition to the buoyancy required by law, the capacity of stowing and sustaining weight. A raft capable of sustaining a certain number of pounds in weight, but without the capacity in feet for carrying persons whose aggregate weight is the same amount, is manifestly useless to save the lives of that number of persons. This matter of weight and ability to handle a life raft without davits, cranes, or machinery of any sort is most important, as those who have tried to launch a boat or raft in a seaway have learned. It is stated that there is not another appliance of its kind in the world capable of saving one-half the number of persons that does not weigh fully five times as much as the Carley float.

The inventor, Captain Horace Carley, is an old whaler and merchant sailor. Information can be had by addressing the Carley Life Float Company, Produce Exchange Building, New York. Many of our warships now have these floats as part of their life-saving equipment.

Errata.—On page 10, January, 1903, MARINE ENGINEERING, the diameter of the low pressure cylinder of tug *Sea Rover* should be 41 inches and the diameter of propeller 9 feet 6 inches.

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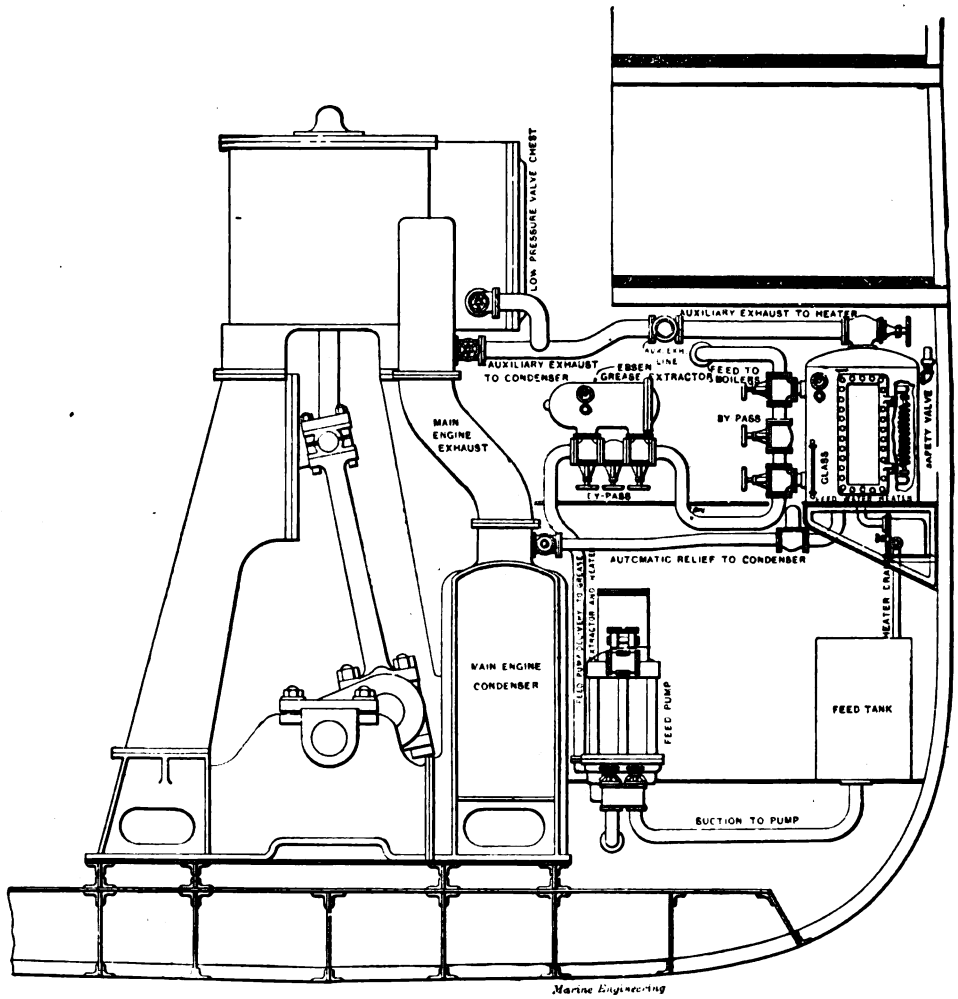
The Multicoil Feed Heater.

Herewith is presented a new style of feed-water heater built especially for marine purposes. It has been in use in a number of large and small vessels for many years and has amply demonstrated its efficiency.

It consists of a cylindrical shell made of light steel, bumped heads, fitted with bronze manifolds top and bottom, which are connected by a series of small helical copper coils by means of ground-joint unions of the Quiggin's patent type. The feed water passes through the coils on its way to the boilers, and the auxiliary exhaust is led to the shell and is entirely condensed, the drains being trapped to the feed tank. Owing to the peculiar construction of these coils, the feed water is agitated in passing through them, so that all the heat from the auxiliary exhaust is absorbed by the feed water. All the necessary appliances are fitted to make this apparatus entirely automatic. The coils are perfectly elastic, and no leakage is possible due to expansion and contraction. Furthermore, the apparatus is very light, as there are no heavy castings, bonnets, or tube sheets.

The steam required for the auxiliary system on shipboard is 10 to 18 per cent. of the capacity of the main boilers, 15 per cent. being the average in the transatlantic service. Owing to the poor efficiency of the auxiliary engines, especially the direct-acting pumps, which are great steam consumers, the greater part of the heat escapes into the auxiliary exhaust, and when this exhaust is led to the main condenser this heat is not only lost, but puts additional work on the condenser, circulating pump, and air pump. The advantages of hot feed water need not be discussed here, as the economy derived from it, as well as the saving of wear and tear on boilers, is well known. In former years a feed temperature of 160 to 180 degrees was considered ample, but in latter years the introduction of high pressures on boilers, in conjunction with forced draft, has made the use of hot feed water imperative, and temperatures at boiling point and above are an absolute necessity for easy steaming.



CONNECTIONS FOR MULTICOIL FEED HEATER.

While the absorption or jet heater, which is frequently used on large sea-going vessels, has to a certain extent solved the problem of attaining high feed temperatures, this system, nevertheless, has many disadvantages. It requires the heater to be placed at least 40 to 50 feet above the feed pump and necessitates using two feed pumps. The highest temperature that can be successfully maintained with this heater is 220 degrees under

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15 pounds back pressure on the exhaust; and as one of the feed pumps must handle the hot feed water at this temperature, the destructive action of such hot water on this pump is very marked, so that even the best type of Admiralty pattern of pump is short-lived. It cuts the water-end packings, rods, and pump liners, the suction and delivery valves hammer out of shape and break, the valve seats are quickly destroyed, and the pumps race and pound, which they will do periodically even with the best of attention, resulting in fractured water ends in comparatively short time, as well as leaky check valves on the boilers.

As stated before, the jet system entails two expensive feed pumps where ordinarily only one is required, as well as complicated piping and valves. On coasting vessels drawing only 15 to 20 feet of water, the distance of a jet heater above its hot feed pump is less than on deep-draft vessels, owing to the lesser depth of hold, with a result that the feed temperature cannot be maintained much over 200 degrees for that size of vessel, while for all smaller vessels the jet heater cannot be used at all. Furthermore, manœuvering the main engines or slowing or stopping at sea necessitates attention to such a heater, and for that reason, when approaching land, the so-called "change over" is effected by entirely disconnecting the heater and putting the auxiliary exhaust in the main condenser, with a consequent readjustment of the speed of all the auxiliary engines and the feed pumps delivering cold water to the boilers.

As the main engine of modern high pressure ships are run without cylinder lubricants, the auxiliary engines are responsible for the oil which gets into the boilers; and as in a jet heater the auxiliary exhaust is mixed with the feed water, the oil of this exhaust is carried to the boilers. Under such condition the only place where a grease-extracting device can be installed is between the hot feed pump and the boilers; and as high feed temperature dissolves the lubricant, especially the lighter oils contained in it, the extractor is only able to remove a small part of the grease.

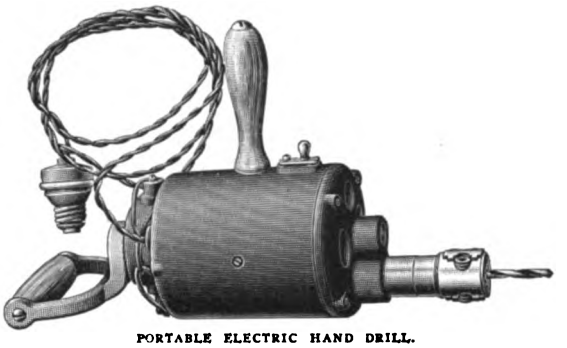
In comparison, the following advantages may be mentioned in favor of the multicoil heater: *It* can be installed on any vessel, from the smallest-size steam launch to a large transatlantic vessel; *it* requires only one feed pump, and that feed pump handles water of only the ordinary hot-well temperature; *it* is absolutely automatic in its action—stopping or manœuvering of the main engines does not affect it in any way.

When sufficient auxiliary exhaust is present the feed temperatures range from 212 to 230 degrees. It can be placed in the lower engine room close to the feed pump and the main auxiliary exhaust line. The back pressure of the auxiliary exhaust line does not exceed 10 pounds, and the feed temperature realized is always equal to the heat of the entering exhaust steam due to its back pressure.

These heaters are made to suit all conditions of marine practice in any size. Particulars may be ascertained by writing James Reilly Repair and Supply Company, 229 West street, New York city.

Electrically-Driven Hand Drill.

A simple portable electrically-driven hand or breast drill has been designed recently by the Hisey-Wolff Machine Company, of Cincinnati. It consists of an enclosed motor suitably geared for driving the drill spindle. The case is provided with two handles, as shown in the engraving, by means of which the tool can be held in any desired position. It may be used in any place where connection can be made with an incandescent lamp socket. It is under perfect control at all times through a switch placed near the vertical handle. The drills are made in



PORTABLE ELECTRIC HAND DRILL.

three sizes, to hold drills from 0 to 1-4 inch, 0 to 3-8 inch, and 0 to 1-2 inch in diameter, at weights of 14, 16, and 24 pounds respectively. Each size is wound for either 110 or 220 volts.

QUERIES AND ANSWERS.

Q. 117.—Will you please advise me through the columns of your magazine the following questions? By doing so you will greatly oblige.

1. The ballast required to sink a floating dock of length 60 feet, beam 40 feet, depth 5 feet 6 inches, wings 10 feet high above floor of dock, 4 feet wide at base, and 3 feet wide at top, so as to float a vessel drawing 4 feet 6 inches of water; height of keel blocks above floor of dock, 4 feet. Draft of dock when light is 3 feet.
2. Will it sink sufficiently to dock vessel without ballast?
3. Is there any rule governing such? M. P. McD.

A.—Since the dock when light, that is, without vessel or ballast of any kind, draws 3 feet, it will be necessary to sink it 11 feet further in order to float in a vessel drawing 4 feet 6 inches over keel blocks 4 feet high. The amount of water ballast required to effect this will exactly equal the additional volume which would be displaced by sinking the dock to this point. That is, it will equal the volume of the dock between the level 3 feet and the level 11 feet higher. It is readily seen that this includes a layer of the main dock 2 feet 6 inches deep and also the wings up to within 16 inches of the top. The volume of the layer of main dock is easily found to be 6,000 cubic feet, while that of each of the wings will be about 1,825 cubic feet, or 3,650 for both. This will give 9,650 cubic feet of additional displacement to sink the dock and this will call for exactly the same amount of water ballast.

If the entire inside of the dock is available for water ballast, then we have only to find how much would be required for this volume of water. The dock being of wood and the dimensions above given being on the outside, the average dimensions of the interior space will not much exceed 59.5 by 39.5. This would give 2,350 square feet of area, and this divided into 9,650 gives 4.1 feet as the depth of water in the dock necessary to sink it to the level required. Actually there is probably

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some timbering inside, which would occupy some space, so that the depth is likely to be somewhat greater than the above, or perhaps about 4 feet 3 inches. It appears, however, that there should be no difficulty in sinking the dock with water ballast to the level designated.

The principles upon which such problems are solved will be sufficiently illustrated by the operation detailed above.

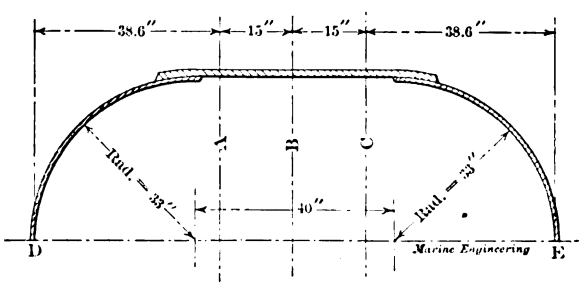
Q. 124.—Can you give me any information concerning the proper size of the propeller to use on a 6 to 8 horse-power engine for driving a light-draft boat? Can the same speed be obtained by using a propeller of 18 inches in diameter of a certain angle as can be obtained by using one of, say, 21 to 23 inches in diameter? The boat draws 18 inches. T. G. K.

A.—It is not possible to give a very definite answer to such a query without more detailed information regarding the dimensions and form of the boat. With the power stated, and with an engine making 350 to 400 revolutions per minute, and at a speed of 8 to 9 miles per hour, a four-bladed propeller about 22 or 23 inches in diameter and with about 30 inches pitch and 160 square inches of blade surface should be employed. The power mentioned cannot be satisfactorily taken care of by an 18-inch wheel with the speed and revolutions likely to be found in the case you mention. In order to obtain the best results with one wheel it will be necessary to use a larger propeller, as noted, and allow it to project below the keel, protected by a skeg, if convenient.

Q. 125.—Will you please give me the blade surface in square feet for a four-bladed propeller to take the place of a three-bladed propeller? The dimensions of the latter are: diameter, 8 feet; pitch, 11 feet; area, 18.3 square feet. We wish the four-bladed propeller to make the same number of revolutions as the three-bladed.

A.—You are advised to put on four blades of about 4.4 square feet area each, or, say, 17.6 square feet in all. This assumes that the diameter and pitch are to remain the same—8 feet and 11 feet respectively. The area—18.3 square feet, as stated—is rather small for a four-bladed propeller and will give rather slender blades; but if the new propeller is to be of the same diameter and pitch as the old, and is to make the same revolutions, the blade area should be about as stated.

Q. 126.—I have a steam drum of the form shown in the sketch. There are two flat sides connected by stays. The distance between the stays in longitudinal view is 19.7 inches. I



calculate the section of the stays B by considering the area supported = 15 x 19.7. As to the stays A and C, I consider the area

supported $= \left(\frac{15}{2} + \frac{38.6}{2}\right) \times 19.7.$

Is the calculation for A and C correct? A. V.

A.—The sketch you send shows, of course, one half of the steam drum. The calculation you make for the stays B is correct. For the stays A and C, however, it is not necessary to consider that they support beyond the flat part. Strictly speaking, these stays might be considered as supporting the area $\left(\frac{15}{2} + \frac{5.6}{2}\right) \times 19.7$. It would, however, be as well to add a little to this provision and make the stays A and C of the same size as B. This would correspond to a support carried over toward the farther edge of the joint. The remaining load produced by the steam pressure estimated in a direction at right angles to DE is carried by the tensile stress set up in the material at D and at E.

Q. 127.—Will you please advise me concerning the Schlicht process of combustion and refer me to some plants which are equipped in this way? F. C. Z.

A.—Briefly, the Schlicht process consists of admitting part of the air for the fires down through the chimney, this air being heated by the upgoing gases and supporting combustion of the fire above the grates and in the combustion chamber. Along the axis of the chimney a pipe is inserted, extending a few feet above the top of the chimney and a few feet below the top.

It is found that the upgoing gases will pass on the outside of this pipe, and there will be a down draft of outside air through the pipe. A company was organized a few years ago to introduce this patent system, and several boiler plants were equipped with it, among which might be mentioned the Arbuckle Sugar Refining Works, Brooklyn, N. Y. This system has worked successfully, but it is evident that the capacity of the chimney is cut down, owing to the increased volumes of air, one passing upward and one downward, and the fact that the upgoing gases, because of the heat which they transmit to the down draft, are cold and therefore decrease the draft.

Q. 129.—Please say what method is adopted for ascertaining the horse power of turbine engines, that is, the indicated horse power, and oblige, W. C.

A.—The only way of learning the horse power of a turbine is either by making a brake test or by driving direct-connected an electric generator. These, of course, do not give the indicated horse power, but the developed horse power. The latter method is preferable, for the load can be learned at any time by the use of volt and ammeters.

If V = volts
A = amperes
W = watts
$K.W.$ = kilowatts = 1,000 watts
$E.H.P.$ = electrical horse power
$D.H.P.$ = developed horse power of turbine
e_1 = efficiency of dynamo

$$K.W. = \frac{VA}{1,000}$$

$$E.H.P. = \frac{VA}{776}$$

$$D.H.P. = E.H.P. \div e_1$$

And as

$$K.W. = 1.3\ D.H.P.$$

$$D.H.P. = \frac{VA}{776 e_1}$$

Q. 130.—How do you compute the work done by a pump? L. P. D.

A.—The net work done by a pump, at the point of final delivery, is readily computed if we know the conditions under which it operates and just what its de-

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livery is. The net work done in the water cylinder will be greater than this by an amount sufficient to provide for the friction of the water in pipes, resistance of curves, elbows, valves, etc.; while the work developed in the steam cylinder of the pump will be still greater by an amount sufficient to allow for the loss due to friction in the moving parts of the pump and for the slippage or leakage in the water end. Thus, for example, with a feed pump putting water into a boiler, the net work performed as measured at the boiler will be represented by the given amount of water forced in against the pressure in the boiler. If the feed pipe is of good size and the lead from the pump short and straight, the work in the water end of the pump will be only slightly more; while if the pump is small and the lead long and tortuous, there will be required a considerable amount of work simply to force the water through the pipe, the pressure on the pump plunger will be increased accordingly, and with it the work done in this cylinder. Again, if the pump is in good mechanical condition and all parts move freely, the work developed in the steam end will be only slightly more than in the water end, while if the condition is poor and the moving parts operate with great friction much work will be lost in this way, and the work developed in the steam end must be correspondingly increased.

To return to the question of measuring the net delivered work of the pump. This may be done most simply by multiplying the weight in pounds of water handled, by the head against which it is delivered, measured in feet. The product will be the work in foot pounds. The head against which the water is delivered may sometimes be measured directly in feet, as when water is simply hoisted or raised from one level to a higher one. On the other hand, it must often be found from the pressure against which it is delivered, by the following:

Rule: Multiply the pressure in pounds per square inch against which delivery is made by 2.304 and the product will be the head in feet. If, in addition to this, the water is raised also, then the height to which it is raised must be added to give the complete head.

These principles will be illustrated by a few examples, as follows:

(1) Six hundred pounds of water are raised 14 feet. How much work is done? Solution: Work=600×14=8,400 foot pounds.

(2) Ten cubic feet of water are forced into a boiler against a pressure of 160-pound gage. What is the net work? Solution: The weight of water will be 62.5×10=625 pounds. The head will be 160×2.304=368.64. Hence the net work=625×368.64=230,400 foot pounds.

(3) Suppose in example (2) that the boiler is 8 feet above the pump and the pump 6 feet above the tank from which the supply is drawn. Then the total head will be 368.64+14=382.64, and the work will be 382.64×625=239,128.

Next, to find the additional work which must be done to overcome the friction of the water in the pipes and passages, it is found most convenient to express the resistance to be overcome in this way as an addition to the head. The amount of such friction resistance or head can only be determined by a rule or formula based on experience. To this end we may use the following formula:

$$h = \frac{W^2 L}{50{,}000 d^5}$$

where h is head in feet, W is weight in pounds of water delivered per minute, L is length of pipe in feet, and d is diameter of pipe in inches. Thus, for example, what will be the head required to overcome the friction in a pipe 2 inches in diameter and 100 feet long, through which there is a flow of 400 pounds of water per minute?

Solution:

$$h = \frac{400 \times 400 \times 100}{50{,}000 \times 2 \times 2 \times 2 \times 2 \times 2} = 10 \text{ feet.}$$

If this water is forced into a boiler against a pressure of 150 pounds, what will be the net power in the water end of the pump?

Solution:

The pressure head will be 150 × 2.304=345.6 feet.

The friction head will be 10 feet.

To this should be added a further allowance for the special resistance due to bends, passage through valves, etc. This can only be estimated, but we will take it in this case to be 6 feet. Then the total head will be 345.6+10+6=361.6 and the work per minute will be 400×361.6=144,640 foot pounds. To find the horse power we divide by 33,000 and find 144,640÷33,000=4.38.

If this is a feed pump of the ordinary type and in good condition, the mechanical efficiency should be from 75 to 80 per cent., though with poor care it may fall much below this. The power required in the steam end will be, therefore, 4.38÷.75 say, or 5.84 horse power.

Additional examples might be given, and special points might be further discussed, but within the present limits of space the foregoing will serve to show the general line of treatment to be followed in the usual case.

Q. 131.—Kindly let me know what the pressure would be in the shell of an evaporator if the slits in the "dry pipe" became clogged up with salt to such an extent that very little steam or vapor could get to the distiller. The steam gage and safety valve are connected between the dry pipe and the distiller and were both useless when the slits became clogged. We were carrying 40 pounds on the coil and it was kept well drained. The steam or vapor valve to the distiller would have to be almost shut in order to keep 5 pounds on the shell. There was about 3 inches of water in the glass and the connections to same were clear. Would there be a limit to the pressure that would accumulate in the shell under these conditions? F. J. McA.

A.—There would certainly be a limit to the pressure which would accumulate in the evaporator under the circumstances mentioned. The highest possible pressure under any such similar conditions would be 40 pounds, the pressure in the coil, and this would only be possible if there was absolutely no escape for any vapor, and if further the shell of the evaporator was so perfectly covered by lagging and non-conducting material that there would be no loss of heat by radiation or conduction. Under these circumstances the pressure in the shell would gradually rise with the increase in temperature until the water and steam in the shell were both at the same temperature as the steam in the

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coil and hence at the same pressure. There would then be no further transfer of heat from the coil to the shell and hence could be no increase of pressure in the latter. Actually this condition could never be realized, for there would always be some small escape of vapor and some loss of heat by radiation and conduction. Your statement that it was necessary to have the vapo. valve almost closed in order to keep five pounds on the shell we assume to mean when the dry pipe is open and clear of salt. This shows that with the opening given by the valve "almost shut," the pressure in the shell would rise to only about five pounds. Even with the dry pipe well salted up there would probably be small likelihood of the pressure in the shell rising beyond 10 or 15 pounds with 40 pounds of steam in the coil. This would be an interesting experiment to make, and one easily carried out. Find the highest pressure you can get in the shell with graded openings in the vapor valve from, say, a full turn open down to tight shut, and report your results for the benefit of our readers. We assume that your pressure gage is between the vapor valve on the distiller and the shell, so that it will give you warning in case any undesirable pressure should be reached.

Q. 132.—Please tell me about what lead the high-pressure valve of an engine 4,000 I. H. P. should have, piston speed 800 feet per minute. Would you have the lead the same for a triple or quadruple expansion engine as for single or compound? J. W. C.

A.—This is to some extent a question of taste with the engineer. Some prefer a generous lead, while others prefer to limit it to the smallest amount permissible. For an engine of the size mentioned the lead might be from 3-8 to 1-2 inch, and there seems to be no reason why it should not be about the same whether in a single or multiple expansion engine.

Explosion of the Progresso.—The evidence that has been brought out at the inquiry into the cause of the explosion of the *Progresso* shows that the oil put on board was of too low a flash test. While California law calls for a flash test of but 110 degrees, this oil was found to flash at from 85 to 101 degrees. There was also evidence that a lighter oil had been mixed with a heavy oil to make it flow more readily.

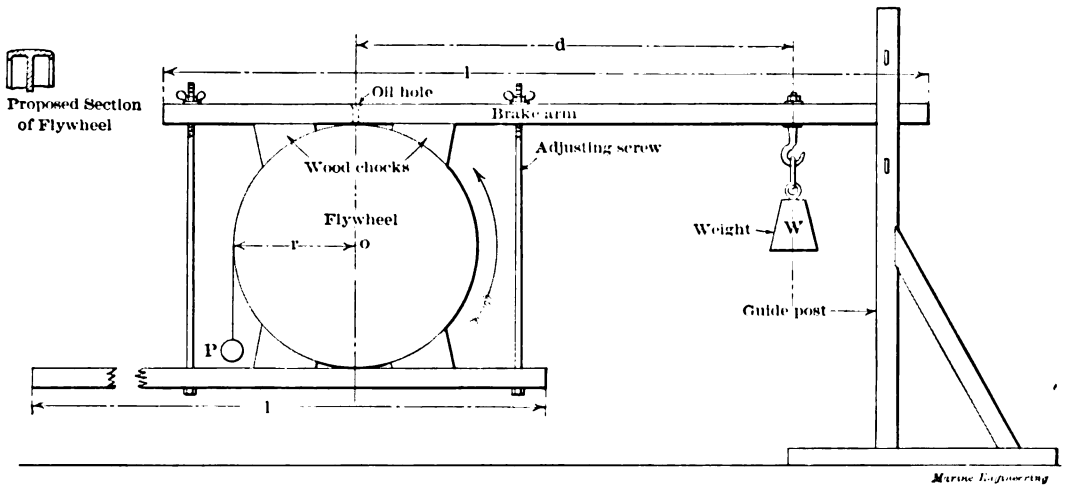
Brake Test of a Gas Engine.

BY ALFRED E. LÜDERS.

The purpose of this article is to give a few hints upon determining the horse power of an engine by what is commonly known as the brake method. Most people know the general idea of the operation; that is to say, they understand that weights are attached to the machine, that the friction is measured and from that the horse power is found. This, of course, is perfectly true, but the few simple little devices utilized to accomplish this end are not so generally known.

To describe the subject properly we will take the test recently applied to a gas engine of a well-known make to ascertain the brake horse power that it developed:

The engine was set up in the machine shop and securely tied to the floor by dogs and bolts in a manner approximating the usual attachment of engine to its foundation in the boat. The exhaust pipe was carried out through the roof, a slight gain in back pressure being realized by the natural tendencies of the hot gases to rise, as against the loss due to forcing the gases out at the stern of the boat through a muffler, and even in some cases exhausting below the water line. Whatever was gained in this manner may have been offset by several right-angle turns in the exhaust pipe, which were naturally a cause of friction. The gasoline was fed to engine by its own pump, forcing gasoline from a small nearby tank through the medium of compressed air, a pressure of about three pounds being obtained in tank by a hand pump to aid the engine in starting. To put a load upon the engine similar to that introduced by the action of the propeller, a brake attachment was rigged up on the flywheel for measuring the power exerted.



FRICTION BRAKE FOR TESTING SMALL ENGINES.

By reference to the figure a good idea of the construction of the brake may be obtained. Two beams are connected by long bolts with butterfly nuts; between them and bearing upon the surface of the flywheel are wooden chucks. The amount of friction applied to the surface is easily adjusted by the butterfly nuts. An oil hole is located over the center of wheel in top arm, as it is necessary to keep the rubbing surfaces running in oil, as the face of the wheel heats very rapidly, caus-

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ing the brake to bind and interfere with the steady running of engine.

On the upper or weight arm a hook is attached, and from this hook weights are suspended, as shown in cut.

Now, presuming that the test is in progress, a known weight being attached to hook, it will be seen that if the butterfly nuts are tightened too much the whole brake will revolve (provided weight is not too great for engine to lift) until lower arm brings up against the floor; again, if the screws are too loose, the end of brake will simply rest on the ground, unaffected by the turning of the engine. The object, therefore, is to adjust the tension on the tie bolts so that the engine may revolve freely, and yet to produce enough friction on the brake arms to just keep weight between the two extremes—*i. e.*, revolving completely or dropping to the ground. When everything is working properly the two arms approximate a horizontal position. If now all is running smoothly, the revolutions per minute are noted, as is also the length of weight arm and diameter of flywheel, and we are then in a position to deduce our horse power.

To understand the method properly reference should be made to the diagram. Here the weight arm, in a horizontal position, has a length $= d$ feet from point of contact on the wheel to the point of suspension on the weight. The radius of the flywheel $= 2r$ and the weight would $= W$. According to the fundamental law of dynamics that action and reaction are equal, we must consider that the resistance to the weight W on the brakes is overcome by a force P applied at a distance of r from the center of the shaft. Then, taking the moment of the force about O, we have $Pr = dW$, or $P = \frac{dW}{r}$. This is the condition when the brake arm is unsupported and when the arms of the brake balance each other, thereby eliminating the weight of brake proper as a factor in the calculation.

Now to find the horse power due to the load P. Let us assume the weight P is suspended by a long cord of no weight attached to the end of the flywheel, and that the wheel in revolving will wind the rope on its face.

Power must contain the three elements of time, space, and force. We have already the latter $=$ to P; let us assume the time to be one minute, then the space traveled will be the number of turns of engine in one minute times the circumference of the flywheel, or $N \times 2\pi r$. Then the work done per minute will $= P \times N2\pi r$, or substituting for P, its value above, we have $2NWd$ foot pounds of work per minute. The horse power $= 33{,}000$ foot pounds of work per minute; therefore,

$$H.\ P. = \frac{2\pi NWd}{33{,}000}.$$

To apply this to the case of engine that was tested: The flywheel being 27 inches diameter, the weight arm was 48 inches long, and the weights used, including a 21-4-pound hook, were 65 1-4 pounds in one case and 53 pounds in the other. To prevent fore-and-aft play of weight a pair of guide posts were set up (see the figure). The posts were just far enough apart to permit of arm moving up and down freely. A couple of pins limited the vertical movement of arm to about six inches each side of the horizontal.

When everything was in readiness the engine was started, the nuts screwed up until the arm oscillated gently between the two stops, the number of revolutions per minute being taken by an indicator. Three runs were made, of which only the first two should be considered, as during the last trial the heating of the flywheel became so great that the brake was continually binding and bringing the weight arm up against the stops with considerable force, thereby putting excessive and intermittent loads on the engine, materially reducing the revolutions and calculated horse power, it being impossible to make an estimate of the work done by hitting the stops.

The motor was rated at twenty-five horse power, and appended is a list of the trials and their results:

Run No.	Weight.	Rev. per Min.	Brake H. P.
1	65¼	500	24.8
2	65¼	540	26.8
3	53	600	24.2
Average....	61.16	546	25.3

[While the method above described will answer the purpose, it is advisable to increase the surface of the wood chucks against the face of the flywheel and steady them from slipping off the flywheel by small blocks nailed to either side of the chucks. Unless some special form of lubricating is used the heating effect due to friction is a serious obstacle in making a reliable test. It is advisable to have a stream of water playing on the face of the pulley, or, where there is an inside ridge on either edge of the pulley, fill this space with water when the engine is running. This will keep the temperature down. Where possible a pair of scales should be used in place of the weight, and a much heavier weight than is necessary placed on the scales and tied to the horizontal brake arm, care being taken to have the cord used in a vertical line; then the zero reading of the scales may be taken with the engine at rest, and whatever load is applied by tightening the butterfly nuts can be read on the arm of the scale by keeping the scales in constant balance.—EDITOR.]

Submarine Torpedo-Boat Destroyers.—It is stated that the British Admiralty is preparing plans for a new type of boat for meeting the attacks of and destroying a submarine torpedo boat.

Twelve Months' Shipbuilding Returns.—The Bureau of Navigation reports 1,262 sail and steam vessels of 429,327 gross tons built in the United States and officially numbered during the year ended December 31, 1902, as follows: On the Atlantic and Gulf coasts, 856 vessels of 214,538 gross tons; in Porto Rico, 9 vessels of 137 gross tons; on the Pacific coast, 161 of 48,432 gross tons; in Hawaii, 4 of 35 gross tons; on the Great Lakes, 104 of 158,230 gross tons; on the Western rivers, 128 vessels of 7,955 gross tons. Wooden vessels numbering 1,137, of 121,269 gross tons, were built in these districts; the only steel sailing vessels were built for the Atlantic and Gulf, and were 9 in number, of 13,345 gross tons; no steel vessels were built in Porto Rico or Hawaii. During the corresponding year, under date of December 31, 1901, 1,322 sail and steam vessels of 376,129 gross tons were built in the United States and officially numbered.

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TECHNICAL PUBLICATIONS.

The Slide Valve and Its Functions. By Julius Begtrup. Size 6 by 9 inches, pp. 143, with 87 figures. Price, $2.00. D. Van Nostrand and Co., New York.

The purpose of the author in the preparation of this work has been to treat the general subject of the slide valve, with due regard to the various requirements of modern practice. The fundamental geometry of the slide valve is discussed and its movements are analyzed by the Sweet form of valve diagram—a form which is less well known than the Zeuner or Belgram diagram, but which the author considers preferable and which he has, therefore, used throughout the work. By the aid of the few fundamental principles as embodied in this diagram a number of special valve constructions are described and analyzed, thus illustrating the varied way in which the exacting conditions of modern practice have been met by modern builders. While the title of the book refers to the "slide" valve, the rotating valves of the Corliss type and others used on "four valve" systems are included in the treatment as well. Extended reference is also made to the various types of independent cut-off gears, both of the older and more modern forms. The slide valve as applied to pumps has not always attracted from writers on this subject the attention which the problems involved have merited. In this book, however, a chapter on the subject is included, and the valve motions found on the leading types of pumps are illustrated and discussed with reference to the problems of steam distribution presented by this class of machinery. The book closes with a chapter on the angularity of the connecting rod and of the eccentric rod, and their influence on the steam distribution with reference to the motion of the piston. A discussion is also given of the use of the rocker arm for equalizing the lead and cut-off, and of various refinements which may occasionally be introduced into the solution of problems of steam distribution.

The marine engineer will miss any adequate treatment of the Stephenson link and other types of marine valve gears. The Stephenson link of the locomotive type and fitted for the reversing rocker arm is briefly referred to, but the student of marine valve gears would hardly find this treatment sufficient for the discussion of the special problems with which he is usually concerned.

In general, however, and within the scope intended by the author, the treatment is clear and adequate for the purposes in view. The style of the author is suggestive rather than exhaustive, and he explicitly states that it is his express purpose to stimulate study and thought on the part of the reader, in order that in his own way he may make the subject his own. The illustrative figures are excellent, as also the presswork and binding, and the book, as a whole, is one which will undoubtedly serve well in its field of special use.

Record of American and Foreign Shipping. 1,300 pages, 8 by 9 1-2 inches. Price $5.00. Published by the American Bureau of Shipping, 66 Beaver street, New York.

The volume for 1903 of the "Record of American and Foreign Shipping," which is the thirty-fifth annual issue of this valuable register, is now being delivered to subscribers. The "Record" contains full reports and particulars of about 17,000 vessels, ranging from the infrequent ketch to the full-powered transatlantic liner and flying the flag of every nation, alphabetically arranged; with much detail as to build, ownership, and condition. This information forms the bulk of the annual volume, but it also contains rules for the construction and classification of all classes of vessels, with illustrations and tables, all of utmost technical and practical value; rules for the construction of machinery and boilers, and suggestions and recommendations for the installation of electrical apparatus on shipboard. The volume contains names of vessels which have been changed; list of compound names arranged alphabetically by last word of name, for ready reference; list of addresses of prominent shipbuilders, dry-docks, and marine railways of the United States; list of owners of vessels, all of much value to the shipping interests.

The work is approved and indorsed by the important boards of underwriters of the United States and is accepted by the merchants and underwriters throughout the world as a standard classification of shipping. Supplements to the volume, issued semi-monthly, keep subscribers informed of new vessels constructed during this year, with reports of repairs to old vessels and other useful information.

The "Practical Engineer" Electrical Pocket Book and Diary for 1903. Size 5 1-2 by 3 1-2 inches, pp. 339, with 64 pages for diary. Gilt edges, flexible morocco, with rubber band and pocket inside of cover. Price 1 shilling 6 pence. Technical Publishing Company, Manchester, England.

This is the fourth annual edition of a pocket book which is intended to be an every-day guide to the electrical engineer, and at a moderate price to furnish him with such formulæ, constants, data tables, and general information as he may need in the daily practice of his profession.

The present edition contains many improvements over previous issues, among which mention may be made of articles on the various conduit systems of wiring, on the comparative expense of operating hydraulic and electric elevators, recent legislation relating to electric installations, etc. The purpose of the editor in the preparation of this book seems to have been well attained, and it may be cordially recommended as a convenient and useful pocket companion for those who are engaged in work relating to applied electricity and electrical engineering in its various branches.

The "Practical Engineer" Pocket Book and Diary for 1903. Size 5 1-2 by 3 1-2 inches, pp. 568, with 64 pages for diary. Gilt edges, flexible morocco, with rubber band and pocket on inside of cover. Price 1 shilling 6 pence. Technical Publishing Company, Manchester, England.

This edition of the engineer's pocket book is the fifteenth published under the same auspices, and represents, therefore, the results of a long series of years in the preparation of engineering literature of this character. The book contains a good selection of engineering tables, formulæ, data, memoranda, and miscellaneous information which the engineer is liable to need at any and all times. The present edition, among other additions, contains tables of equivalents of feet and inches with millimeters, between 1-32 inch and 2 feet by increments of 1-32 inch, and between 1 inch and 20 feet by increments of 1 inch.

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The subject matter seems to have been well selected, and the book should prove a most acceptable pocket companion for the engineer in the practice of his profession.

SELECTED MARINE PATENTS.

715,261. LIFE PRESERVER. JOSEPH B. HAMILTON, SPRINGFIELD, MASS.

Claim.—1. A life preserver composed of an annular casing of textile or other flexible material, and having enclosed therewithin segments of cork or like buoyant material, said casing being provided with an inwardly-extending annular flexible lip provided with a tube *f* and having enclosed therein a ring of flexible material substantially as described. Two claims.

715,325. PILOT-HOUSE INDICATOR FOR STEAMBOATS, ETC. JOHN N. WAINMAN, EVANSVILLE, IND.

Claim.—1. In a device of the class described, the combination with a movable indicator adapted to travel in opposite directions from a neutral point and a spring adapted for retracting said indicator or moving it in one direction, of an alarm sounded by the movement of said indicator when it passes its neutral position, and an operative connection between said indicator and the engine-controlling lever, whereby the movements of the lever are duplicated by the indicator and the alarm sounded on the movement of the indicator from its neutral position. Three claims.

715,395. PROPELLER-CONTROLLING DEVICE FOR SUBMARINE BOATS. SIMON LAKE, BRIDGEPORT, CONN. Five claims.

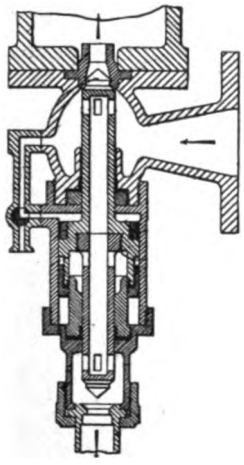
715,882. BOW-FACING ROWING MECHANISM. DANIEL R. SHEEN, PEORIA, ILL. Ten claims.

715,938. LIFE PRESERVER. JOHN E. ARMSTRONG, SANTA CRUZ, CAL.

Claim.—1. A life preserver or buoy including a narrow breast float and a segmental float to be positioned back of the head, and means for adjustably attaching the floats, said floats capable of automatically positioning the body face upwardly while in the water. Seven claims.

715,939. LOG RAFT. JOHN AYRES, PORTLAND, ORE., ASSIGNOR TO OREGON RAFTING COMPANY, PORTLAND, ORE. Six claims.

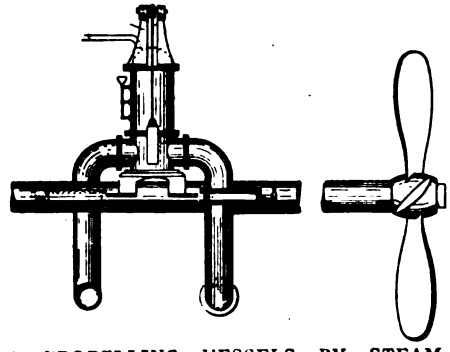
716,418. ASH EJECTOR. LUDWIG HOCHSTEIN, DIETRICHSDORF, GERMANY.



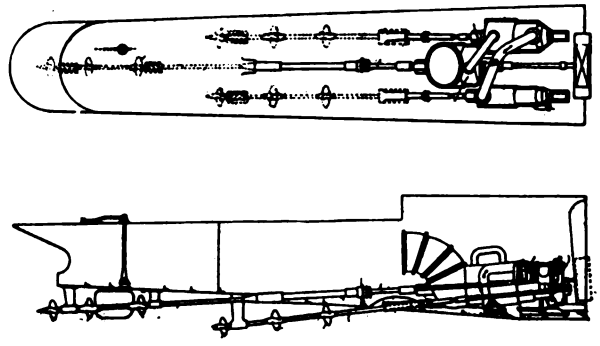
Claim.—1. An apparatus for permitting the pumps of ash ejectors to be kept in continuous action comprising in combination: two valve seats; a valve cone adapted to close each valve seat; a tube connecting said valve cones and having openings near each valve cone; a piston body mounted on said tube; a chamber enclosing said piston body; a chamber enclosing each end of said tube; a pressure main connected with one of the chambers surrounding the ends of said tube; channels connecting one surface of said piston with the chamber connected with said pressure main and with the atmosphere; and a cock adapted to open and close said channels according to desire; substantially as set forth. Four claims.

716,123. MEANS FOR PREVENTING RACING IN SCREW-PROPELLED VESSELS. GEORGE SOLLITT, HASTINGS, NEW ZEALAND.

2. In appliances for preventing racing in screw-propelled vessels in combination, an air-tight cylinder fitted vertically within the vessel, a chamber beneath the cylinder communicating therewith, pipes leading from the chamber through the hull of the vessel, a piston within the cylinder provided with a piston rod projecting through the top end of the cylinder, counterweights attached to the piston rod, an auxiliary air-tight cylinder provided with a piston and piston rod connected to gearing adapted to open and close the valve of the steam pipe leading to the engines, and a pipe connection leading from the top end of the main cylinder to the bottom end of the auxiliary cylinder, as herein specified. Two claims.



716,468. PROPELLING VESSELS BY STEAM TURBINES. CHAS. A. PARSONS, NEWCASTLE-UPON-TYNE, ENGLAND.



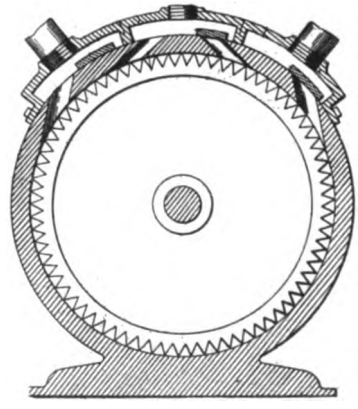
Claim.—In combination with the vessel, a plurality of steam turbines, a propeller connected to each turbine whereby the required blade area is obtained and a steam supply, the said turbines being connected thereto in series whereby the steam passes through the turbines in series and the whole expansive force is utilized and distributed to the several propellers, substantially as described. Two claims.

716,617. MARINE SIGNALING APPARATUS. WILLIAM B. BARKER, LIVERPOOL, ENGLAND. One claim.

716,678. METHOD OF COATING SHIPS' BOTTOMS OR OTHER OBJECTS. ALONZO P. CUTHRIELL, PORTSMOUTH, VA., ASSIGNOR OF TWO-THIRDS TO CHARLES A. McLEAN AND HARRY L. MAYNARD, PORTSMOUTH, VA.

Claim.—1. A method of coating ships' bottoms and other objects, consisting of applying anti-corrosive composition thereto consisting of ferric oxid, oxid of zinc, shellac varnish, linseed oil, turpentine, and oil of pine tar, drying the said coating, and then applying a coating of an anti-fouling composition. Three claims.

716,791. ROTARY MOTOR. DELEVAN P. UPSON, JACKSONVILLE, FLA.



Claim.—A rotary impact motor comprising a cylinder or casing, a shaft extending therethrough, a piston having a widened peripheral portion, and having in its periphery a plurality of transversely-extended recesses forming piston blades, an inlet port leading through the cylinder or casing, said inlet port having a cross-sectional area equal to that of the piston blade against which the actuating fluid impinges and the port being disposed on a line tangential to the piston and in a plane at a right angle to the plane of the piston blades when opposite said

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port, and an exhaust port also formed in the cylinder or casing and extending on lines similar to those of the fluid-inlet port. One claim.

716,908. ELASTIC-FLUID TURBINE. TORE G. E. LINDMARK, STOCKHOLM, SWEDEN. Nineteen claims.

716,936. STEAM TURBINE. JOHN RICHARDS, SAN FRANCISCO, CAL.

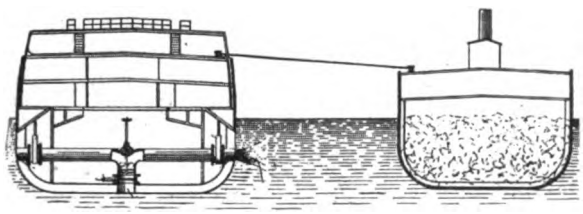
717,059. TURBINE ENGINE. SAMUEL J. WEBB, MINDEN, LA. Six claims.

717,101. SUBMARINE BOAT. SIMON LAKE, BRIDGEPORT, CONN. Twelve claims.

717,196. MEANS FOR CONVEYING OIL FOR CALMING WAVES. CHARLES LA FLETCHER HILLMAN, SANTIAGO, CHILE.

Claim.—4. An apparatus provided with a tube having discharge apertures, and tube provided with another non-perforated tube arranged parallel thereto and adapted to supply the material employed, that with apertures being extended to or near a deposit or point whence the tube without apertures receives its material. Eighteen claims.

717,356. MEANS FOR COALING SHIPS AT SEA. ANDREW C. CUNNINGHAM, WASHINGTON, D. C.



Claim.—2. The combination of a ship to be coaled, a collier or supply ship, a flexible connection athwartships between said ships of sufficient length to permit both ships to roll and pitch without interference with each other, and means for creating a lateral pressure between each of said ships and the surrounding water on the side toward the other ship sufficient to maintain them at such distance apart. Two claims.

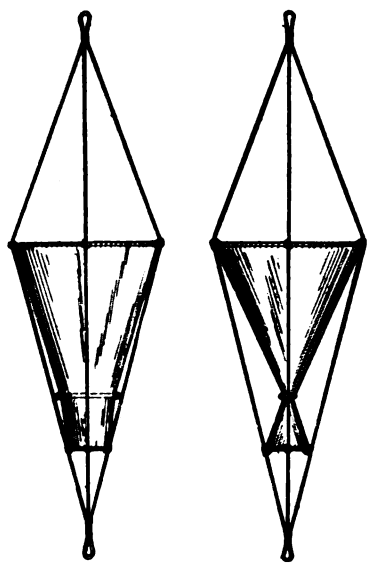
717,563. APPARATUS FOR HANDLING AUTOMOBILE TORPEDOES. BRADLEY A. FISKE, U. S. NAVY. Four claims.

717,590. SHIP'S RUDDER. OSWALD S. MEARS, BLOOMTOWN, VA., ASSIGNOR OF ONE-HALF TO H. C. DARBEE, SEAFORD, DEL.

Claim.—1. The combination with the ship having a chamber adjacent to its stern post, said chamber having side openings adjacent to the said stern post, ot a movable rudder and post to which it is connected, and means for moving said post and rudder.

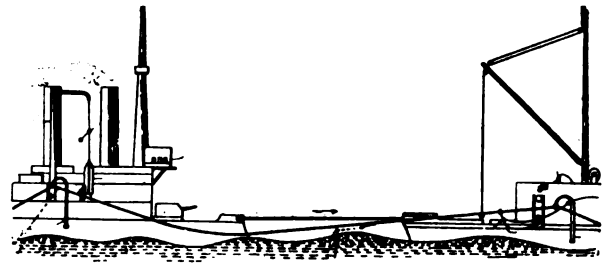
2. The combination with a ship having a chamber adjacent to its stern post, of a supplemental rudder located in said chamber and adapted to move rearwardly to bring the same in operation, and means for moving the said rudder, as described. Four claims.

717,890. SEA ANCHOR. THOMAS S. MILLER, SOUTH ORANGE, N. J. FILED JAN. 24, 1901. SERIAL NO. 44,498. (NO MODEL.)



Claim.—2. A sea anchor consisting of a hollow structure adapted to permit passage of the water therethrough and having a relatively contracted discharge opening of variable area, and means for attaching a cable to the end of the anchor. Fourteen claims.

717,682. DEVICE FOR LOADING VESSELS. FRANK HONECK AND ROBERT H. HOPKINS, SEATTLE, WASH.



Claim.—2. A pull boat, a pulled boat, a tow line, a guide cable extending from one boat to the other and disposed in proximity to the water line, a buoyant receptacle adapted to be moved through the water and having means for connecting the same movable on said guide cable, substantially as described. Eighteen claims.

718,006. SOUNDING APPARATUS. JOHN F. LEWIS, PHILADELPHIA, PA. Three claims.

718,156. PROPELLING MECHANISM FOR BOATS. DOURA C. PUTNAM, LYONS, N. Y.

Claim.—1. A propelling mechanism for boats comprising a support, intermeshing gears journaled on the support and provided with angular brackets disposed at the same side of their respective axes when the brackets are in their operative position, and oar sections having their adjacent ends secured to said brackets. Six claims.

718,162. PROPELLING MECHANISM FOR BOATS. DANIEL R. SHEEN, PEORIA, ILL. Fifteen claims.

718,368. MARINE CONVEYER. THOMAS S. MILLER, SOUTH ORANGE, N. J.

Claim.—1. In a marine conveyer the combination with a cableway having a transit rope extending between two vessels, a carriage actuated by said transit rope, and means exterior to both of said vessels for actuating said transit rope to convey the load carriage from one vessel to the other. Eleven claims.

Monitor Nevada.—The last of the four single-turreted monitors, the *Nevada,* recently underwent her official trial over the Cape Ann course. The ship made, according to official report, 12.8 knots speed for one hour. The vessel was contracted by the Bath Iron Works for $960,000.

Captain A. F. Lucas.—The oil-tank steamer *Captain A. F. Lucas,* under construction at Wm. R. Trigg Company's yard, Richmond, Va., was built from the designs of Mr. D. E. Ford, Philadelphia, consulting engineer for the Standard Oil Company. The steering engine will be supplied by Williamson Bros. Company, Philadelphia, Pa., instead of as stated in the description which appeared in the December number of MARINE ENGINEERING.

Oil Fuel.—A very serious setback in the oil-fuel trade has been occasioned by the advance in the price of crude oil and the diminishing of the output of the Beaumont wells. Last summer many of the gushers ceased to gush and since then many of the wells have given decreased quantities of oil. Reports from several shipyards state that no new contracts for equipping tank steamers are being given out, and that wherever possible old contracts have been canceled. The output from other oil fields, however, is not checked.

Iron Ore Shipments.—The iron ore shipped on the Lakes from American ports during 1902 amounts to 27,039,169 tons. This does not include 298,420 tons shipped from the Clerque mines in Canada nor the shipments by rail to furnaces near the mines, which are estimated at about 450,000 tons. Thus the grand total will be close to 28,000,000 tons, which is more than was mined or produced in the thirty-one years between 1855 and 1885 inclusive. It is nearly three times the output of 1896, and represents an increase of about 35 per cent. of last year.

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Marine Engineering

Vol. 8. NEW YORK, MARCH, 1903. No. 3.

GREAT LAKES GRAIN TRAFFIC.

BY R. J. DONOVAN.

Among those necessities of life furnished by the vegetable kingdom there are probably no more important products than those generally specified as grain, *i.e.*, wheat, corn, oats, etc. The growth of grain and its distribution to the various parts of the inhabited world have always demanded the services of a large percentage of those "who earn their bread by the sweat of their brow." The ship from ancient times has been the chief means of transportation of the grain crops, and we remember reading with what anxiety the hungry Romans awaited the coming of the grain-laden fleets from Africa, and have noted the frequent allusions to the same subject in the Bible.

Among those portions of the earth adapted to the growth of grain there are probably no sections so richly endowed by Nature for that purpose as the great rolling plains of the West and Northwest of our own country and Canada. These sections not only possess peculiar natural advantages in the soil, but they also border on the greatest natural highway of the world—the Great Lakes.

The remarkable growth and development of navigation and commerce on the Great Lakes is without parallel both in its rapidity and extent. Competition with railroads, particularly in the handling of bulk freight, such as grain, ore, coal, etc., has lately changed conditions previously existing. The altered condition of trade has very largely changed the type of vessel required, and has necessitated revisions of construction, so that at the present date there has been evolved a type of vessel peculiar to the lakes and eminently fitted for the purpose intended.

LIFTING BRIDGE AND GRAIN ELEVATORS AT BUFFALO, N. Y.

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Mechanical appliances at the various lake ports for the rapid handling of cargoes are, perhaps, unequaled in any part of the world, and the construction of the lake freighter must be such as to meet these modern and improved methods and conditions. So we may say that the greatest economy has been obtained not

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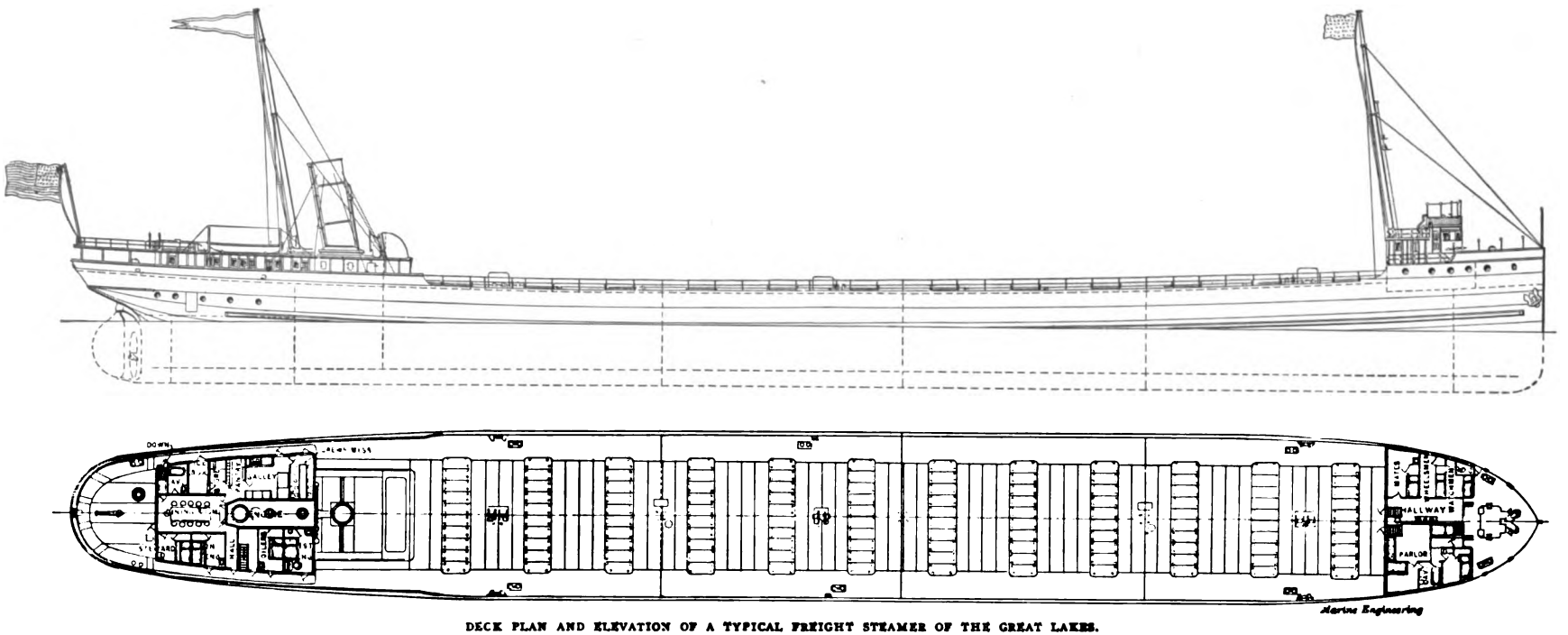

DECK PLAN AND ELEVATION OF A TYPICAL FREIGHT STEAMER OF THE GREAT LAKES.

only by the rapid terminal facilities, but also by the ability to transport, with the least operating cost, the greatest tonnage.

The purpose of this account is to give the reader a brief but accurate description of the Great Lakes grain traffic; involving a short account of the elevator, of the operations necessary in the handling of grain, and the vessels engaged in the trade. With a view to aid the reader in understanding the situation, we will suppose that he has arrived at Duluth or some other upper lake port to study the question.

The grain as it arrives from the West and Northwest is received by the elevator for storage until it is again shipped. The elevator is a large, barn-like structure, impressing the observer rather with its bulk than with its beauty. Its purpose is to receive, discharge, and hold grain in storage. Structurally, the elevator consists of an assembly of parts and suitable machinery for elevating and discharging grain, scales for weighing it, and bins or tanks for storing it. The grain as it is shoveled from the car is caught in the "lofter" pit and carried up by some conveyance system to the weighing hopper, where, after a certain weight is received and recorded, it is carried by gravity or by some system of conveyance to storage bins; in some cases passing through cleaning and drying operations on the way. It may, however, be transferred to vessels or to other cars through the discharging spouts. The accompanying sections of modern grain elevators will serve to aid the reader in understanding the construction.

We will now suppose that a *freighter* of the largest size—say 440 feet long—has arrived at the elevator for a load of grain. The hatch covers are taken off, and, the preliminary work of adjusting the discharging spouts being over, the grain is allowed to flow into the hold of the vessel through several hatches at once. As the season of navigation is limited by ice to about seven months in the year, despatch in port is of the utmost importance and bulk cargoes are all spouted in—coal and ore from elevated dock structures—and taken out by machinery at the dock, no hoisting machinery being carried by the boat itself.

The cargo has now been received, and, the work of trimming being over, the vessel starts on her way eastward to Buffalo, the great eastern terminus of the lakes'

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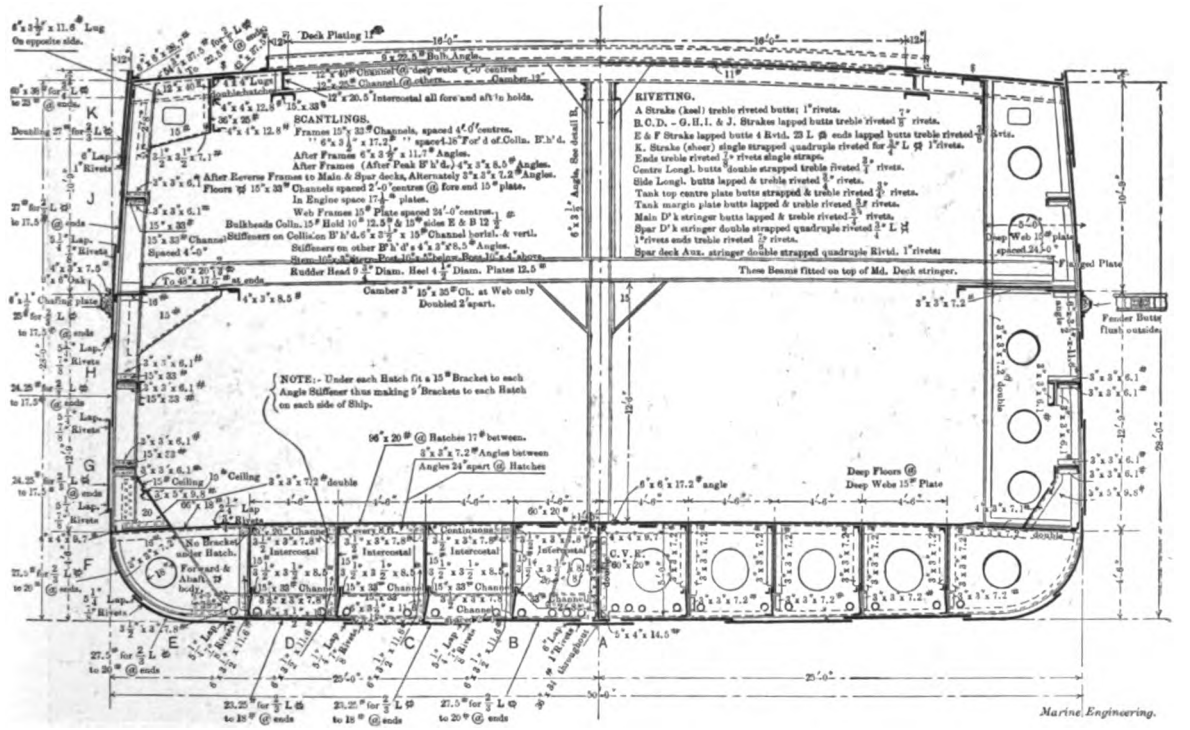
traffic. The movement of grain and ore is entirely from upper to lower lake ports, and of coal in the opposite direction. As, however, there are a great number of wooden vessels still in the service which require up cargoes, and as coal cannot be unloaded rapidly and the freight rate being generally quite low, the big steel vessels, especially those belonging to the great steel and transportation companies, go back light or use water ballast when any is required.

The majority of modern lake steamers are designed to carry only grain, ore, and coal in bulk, and so no deck is needed or is laid on the main-deck beams in the cargo hold. Due to the fact that all bulk cargoes are spouted in, the hatches are many in number and very wide. As the connecting channels between the lakes are comparatively shallow, the vessels are built with flat-plate keel and very little rise to the floor and very full model, so as to get the maximum carrying capacity on the limited draft available. On arriving at an elevator or loading dock in a light condition, these vessels, therefore, float very high out of the water, and, to obtain the necessary slope for the spouts and elevator "legs," the hatches are made as wide as possible transversely, leaving the stringer on each side to take care of the strength (the hatches actually being from 24 to 30 feet wide in vessels of 48 and 50 feet beam). Sometimes the water bottom is filled, thus depressing the deck; but this, in general, is not allowable, since it is evident that a cargo can be spouted in much faster than the water can be pumped out.



MIDSHIP SECTION OF A TYPICAL FREIGHT STEAMER OF THE GREAT LAKES.

SCANTLINGS.

Frames 15-inch by 33-pound channels, spaced 4 feet 0 inches centers.

Frames 6-inch by 3 1-2-inch by 17.2-pound channels, spaced 18 inches forward of collision bulkhead.

After frames 6-inch by 3 1-2-inch by 11.7-pound angles.

After frames (after peak bulkhead) 4-inch by 3-inch by 8.5-pound angles.

After reverse frames to main and spar decks alternately 3-inch by 3-inch by 7.2-pound angles.

Floors, midship section, 15-inch by 33-pound channels, spaced 2-foot 0 inch centers at fore end, 15-pound plate.

In engine space 17 1-2-pound plates.

Web frames, 15-pound plate, spaced 24 feet 0 inches centers.

Bulkheads, collision, 15 pounds; hold, 10 pounds, 12.5 pounds, and 15 pounds; sides, E and B, 12 1-2 pounds.

Stiffeners on collision bulkhead, 6 inches by 3 1-2 inches. 15-pound channel, horizontal and vertical.

Stiffeners of other bulkheads, 4-inch by 3-inch by 8.5-pound angles.

Stem, 10 inches by 3 inches; stern post, 10 inches by 5 inches below boss, 10 inches by 4 inches above.

Rudder head, 9 3-4 inches diameter; heel, 4 1-2 inches diameter; plates, 12.5 pounds.

RIVETING.

A strake (keel) treble-riveted butts, 1-inch rivets.

B, C, D, G, H, I, and J strakes lapped butts, treble riveted, 7-8-inch rivets.

E and F strakes lapped butts, 4 riveted, 2-3 L midship section; ends lapped butts, treble riveted, 7-8-inch rivets.

K strake (sheer) single-strapped, quadruple riveted for 3-4 inch L midship section, 1-inch rivets.

Ends treble riveted, 7-8-inch rivets, single straps.

Center, longitudinal butts, double strapped, treble riveted, 3-4-inch rivets.

Side, longitudinal butts, lapped and treble riveted, 3-4-inch rivets.

Tank top-center plate butts strapped and treble riveted, 3-4-inch rivets.

Tank margin--plate butts lapped and treble riveted, 3-4-inch rivets.

Main deck stringer butts lapped and treble riveted, 3-4-inch rivets.

Spar deck stringer double strapped and quadruple riveted, 3-4 L midship section, 1-inch rivets. Ends treble riveted, 7-8-inch rivets.

Spar deck auxiliary stringer double strapped and quadruple riveted, 1-inch rivets.

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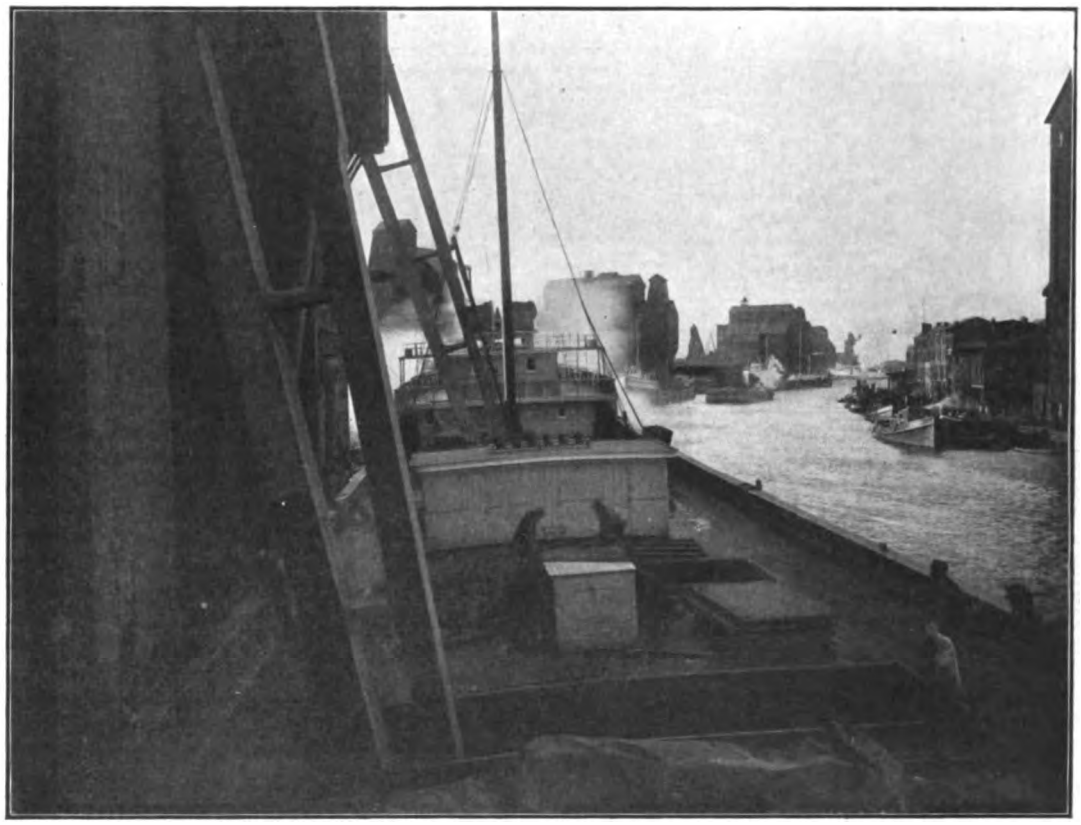
Coal and ore docks have their spouts and unloading apparatus uniformly spaced twelve feet centers, so we find all hatches on lake crafts spaced 24 feet centers and usually 8 feet long; however, there are a few boats now with hatches spaced 12 feet centers. The stanchions supporting the spar deck between the hatches are of channel section and are as few in number as is consistent with the weight to be supported and general strength considered.

The frame spacing in the latest construction in the larger type of lake vessel is 4 feet above the tank and 2 feet for the floors below—both frames and floors being of channel section. In most of the large boats a deep web frame, with corresponding deep-plate floor, is fitted every 24 feet and arranged to come between the hatches. For convenience in handling various cargoes the large hold space is usually divided into three or four compartments by screen bulkheads.

The danger of grounding in the narrow and, in many places, rocky channels connecting the lakes is very considerable, and double bottoms are a necessity and are carried straight across on top to protect the bilges to the upper turn. To get sufficient water ballast, as well as to raise up a heavy cargo, such as wheat or ore, and make the ship easier in a seaway, the tank is made deep—from 5 to 6 feet at the center line. In carrying out the design, great care must be exercised in securing proper strength in the water bottom to sustain the load and also to support the bottom in the event of grounding. The midship section shows this construction very clearly, and in this connection the reader should note the universal use of shaped sections whenever possible.

To avoid the interruption of the loading spouts, as well as to avoid the inconvenience of a shaft alley in the cargo hold, the machinery is placed aft—the engine going as near the stern post as the shape of the vessel will permit, and the boilers and bunkers are placed next forward, either on the tank top or on a special deck with cargo space beneath. The longest straight run in open water is across Lake Superior, a distance of about 400 miles, and the total voyage between, say, Duluth and Buffalo, being under 1,000 miles; and as coal for fuel is available at various points in the connecting channels, the coal supply is not great. Recently, however, attention has been called to the high price of fuel at upper lake ports, so that large bunkers are arranged.



UNLOADING GRAIN INTO ELEVATORS.
[Copyright. 1900. Detroit Photographic Co.]

The machinery of the boat is modern in all particulars and consists of two or three Scotch boilers supplying steam at 150 to 180 pounds pressure to a triple-expansion engine and the necessary auxiliary machinery, including ballast pumps of large capacity. Some of the vessels of this type and size have been fitted with water-tube boilers and quadruple-expansion engines; but this equipment is not common. The horse power of the engine is comparatively low when the size of the boat is considered, but is ample to propel the vessel on a draft of 18 feet at from 10 to 12 miles per hour, a speed found to be the most economical for the lake freighter.

The accommodations for the officers and crew and occasional passengers are at the extreme forward and

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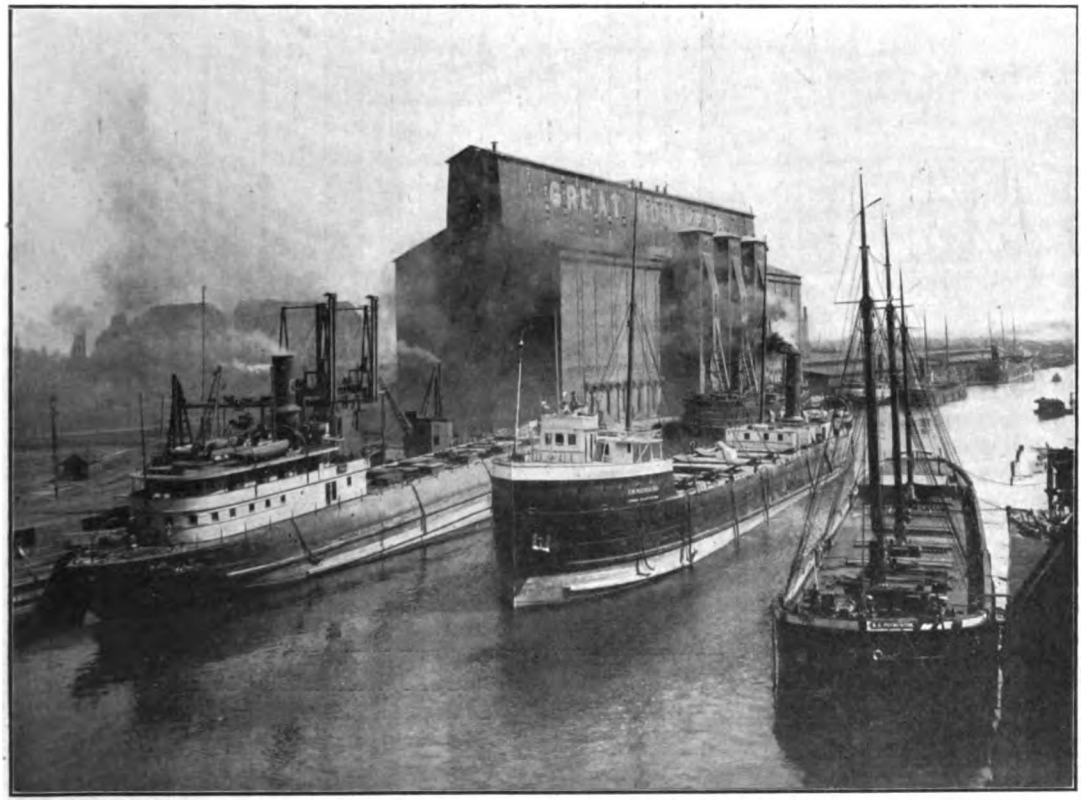
after ends of the ship, thus leaving the working deck free from all obstruction. However, some boats have a small deck house amidships. In the forward part of the ship are usually provided the owner's suite of rooms and quarters for the mates, wheelsmen, and watchmen; while above in the Texas, adjoining the pilot house, the captain has his apartments and chart room. The after deck house, forming part of the boiler house, contains the galley, pantry, dining room, crew's mess, and quarters for the engineers, oilers, and stewards, with occasionally a spare room or two. The deck hands and firemen are usually quartered below, just aft of the engine hatch, on a partial deck or on the level of the handling deck.

During these observations the vessel has approached the Sault Ste. Marie ship canal, commonly known as the "Soo," and after the necessary operations involved in passing the locks are performed, the ship steams on her way eastward. We will here present a few bits of information concerning the Soo which will give the reader a good idea of the extent of the lake traffic. At the close of this season it is reported that about 27,000,000 tons of ore passed through the canal, about 3,000,000 tons of wheat, and about 6,000,000 tons of general freight. Without exaggeration there is probably no other highway through which a greater amount of commerce passes.

All along the route the observer sees evidences of the



GREAT NORTHERN ELEVATOR AND SHIPPING AT BUFFALO, N. Y.
[Copyright, 1900, Detroit Photographic Co.]

The joiner work in the cabins presents a finished and pleasing appearance to the eye, and the oak and other hard woods usually employed suggest an idea of comfort and endurance. Electric lighting is used throughout the vessel and a searchlight is provided for making docks, etc. All living quarters are heated by steam, and in general fittings and equipment the boat is not at all inferior to any coast vessel engaged in similar trade. We would here remark that, due to a misunderstanding of the situation, the lake freighter is generally considered and specified on the coast, in respect to size and equipment, as a barge, and so great surprise is expressed by salt-water sailors on inspecting for the first time one of these barges 450 to 480 feet long. Taking everything into consideration, the vessel presents from the outside a not ungraceful appearance with her slender pole masts and smokestack raked appreciably aft.

vastness of the steel and iron industry of our country in the numerous freighters of the largest size. Many of these have silver-colored stacks, which are the distinctive features of the Pittsburg Steamship Company's fleet, controlled by the United States Steel Corporation. Now and then a whaleback steamer passes by and attracts the observer's attention by its peculiar appearance. These boats were quite popular a few years ago, but, due to several reasons, they are no longer built. Here an oldtime schooner comes in sight, a relic of the enormous sailing fleet that once covered these waters; there a great log raft is seen with several tugs steering it slowly along, an evidence of the vast lumber traffic of the Great Lakes.

We have now arrived at Buffalo and the ship makes her way to some particular elevator, according to her contract, and prepares to discharge her cargo. The

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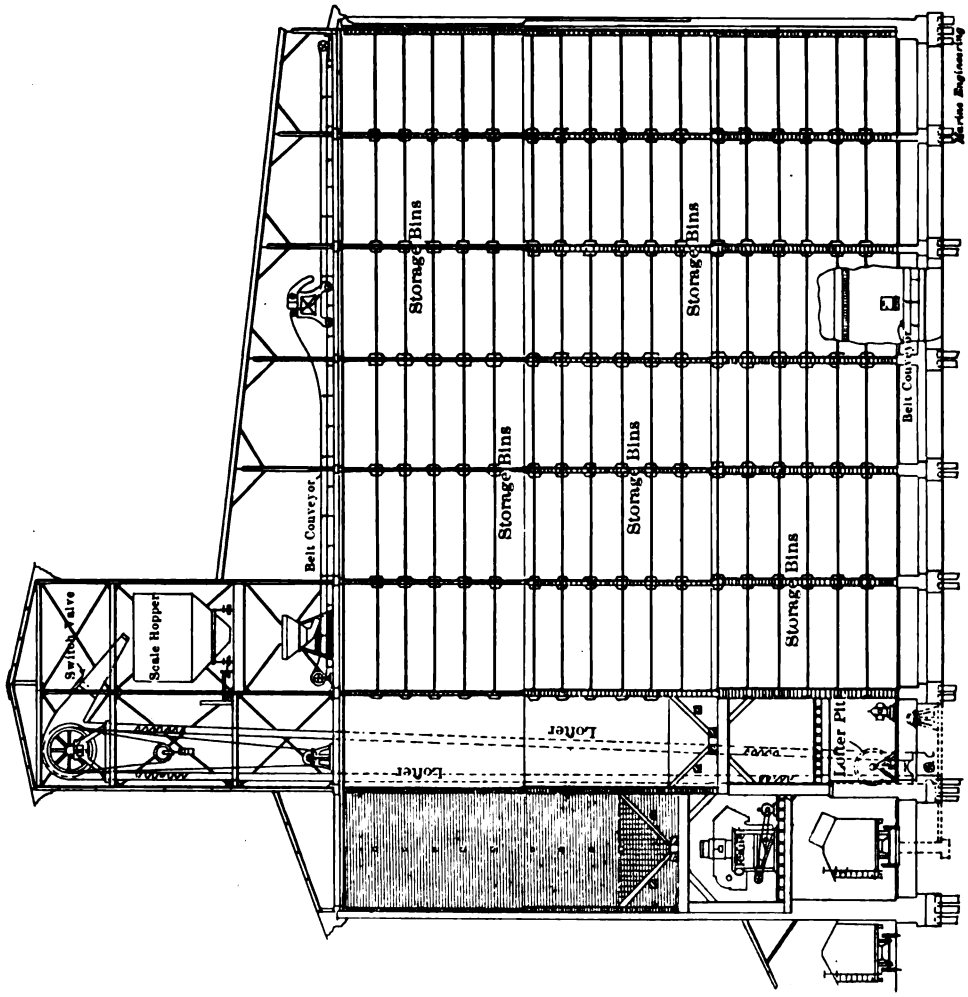
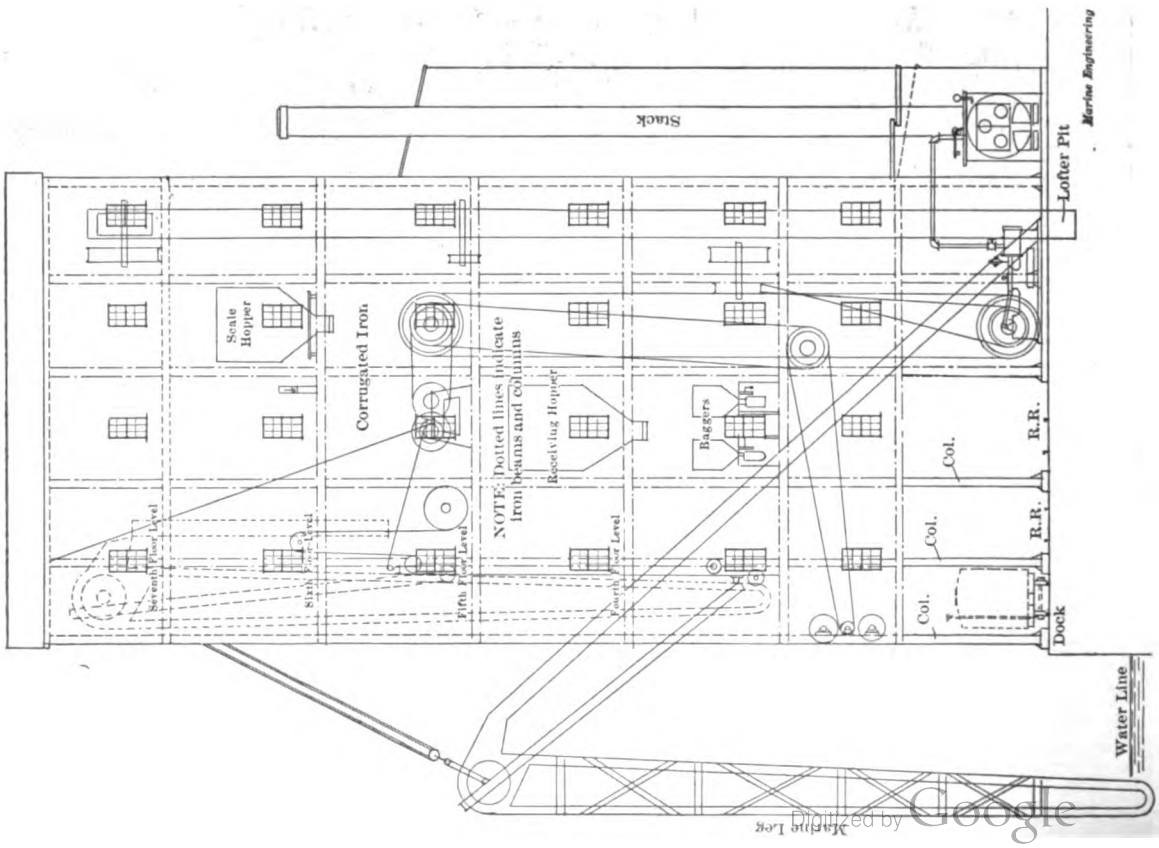


BRICK ELEVATOR, 1,000,000 BUSHELS CAPACITY.



WOODEN ELEVATOR, 750,000 BUSHELS CAPACITY.

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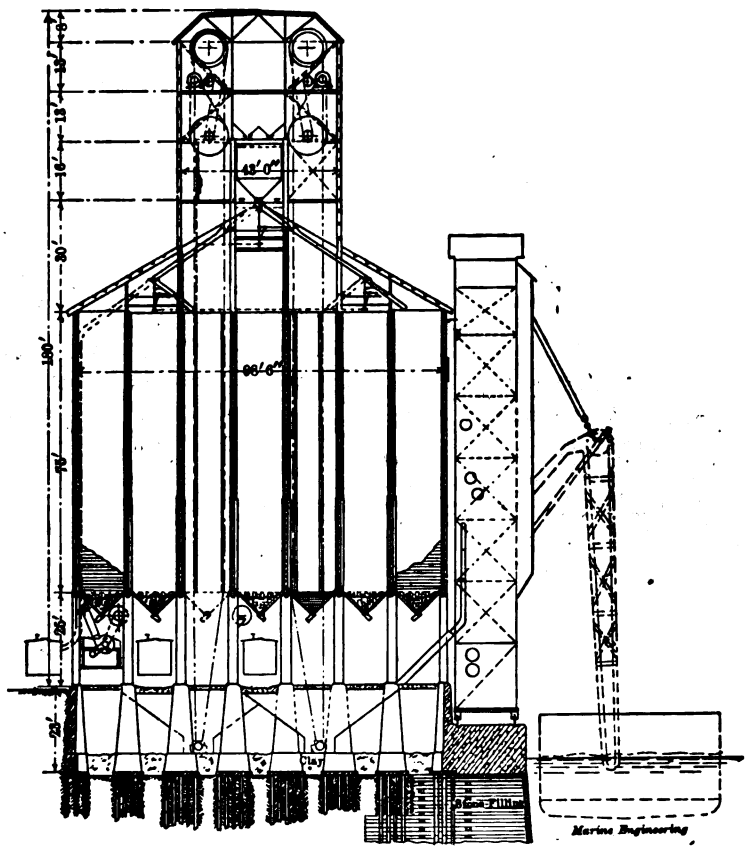
hatch covers are lifted off and one or more marine elevators, or "legs," are lowered into the hold. The marine leg is a framework or steel structure supported at the elevator end, so as to allow the other end, which rests in the hold of the vessel, to adjust itself to the varying levels of the grain. The leg carries a system of buckets or pockets, which are fitted to an endless belt actuated by power received through rope gearing from the power plant of the elevator. The buckets, as they travel up and down the leg, catch up the grain and discharge it at the top of the leg into a chute leading down to the lofter pit, where it is caught up as before and carried to the weighing hopper. These legs take out grain with great rapidity, each one being able to elevate from 15,000 to 18,000 bushels per hour. When the level of the grain has been lowered to within a short distance of the tank top, steam shovels are fitted and worked through rope purchases from the elevator, so as to collect the grain about the leg. Down in the hold, in the dust-laden atmosphere—so dense that one can hardly see—gangs of men with ears, eyes, and nose covered with some sort of protection, and armed with large scoop shovels, feed the steam shovels. This work is very trying, and none but experienced and powerful men can stand it long, but a strong inducement is offered in the wages, which amount to about 40 cents per hour.

The vessel now leaves the elevator and probably looks around for an up cargo of coal or returns to Duluth for another cargo of grain.

The grain is held in storage or transferred to cars or to canal boats. These latter, having received their cargo, commence their slow journey down the canal, and on arriving at New York discharge at certain points for domestic use or for exportation abroad.

Before closing we will present a few facts concerning Buffalo as a great commercial center, and the economics of the grain trade. During the last season the shipping tonnage arriving at Buffalo amounted to 5,300,000 tons, and the amount of grain received reached 130,000,000 bushels. There are 24 large elevators in Buffalo, with a total capacity of about 20,000,000 bushels.



PROPOSED STEEL ELEVATOR, 1,000,000 BUSHELS CAPACITY.

Besides being a great lake port, Buffalo is one of the largest railroad centers, having trunk line connections to all parts of the country. The grain (let us take wheat for example), as it arrives at Duluth or other upper lake port, is probably worth from 50 to 70 cents per bushel. The elevation of the grain amounts to from one-quarter of a cent to one cent per bushel. The capital invested in the elevator varies from 18 cents to 30 cents per bushel capacity, respectively for wood and steel elevators, while the capital invested in the grain carrier varies from, say, $1 to $1.25 per bushel capacity of the vessel. The trimming of the grain in the vessel's hold is paid for by the boat and varies at different ports—at Duluth it amounts to 50 cents per 1,000 bush-

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els, while at Chicago it is 75 cents per 1,000 bushels. The cost of transportation varies from 1 1-2 to 3 cents per bushel, depending on the season and market. In the old days of sailing vessels very high rates were sometimes paid, and in 1872 we find a rate of 25 cents per bushel from Chicago to Buffalo. All unloading is done by contract, to be paid by the boat—that is, the cost is deducted from the freight bill. The question of "overage" and "shortage" is settled by the terms of the contract, which always guarantee delivery at the receiving elevator of a certain definite amount. Should a shortage happen the boat must make good the deficit at cost price of the grain, while should an overage result the boat is paid for the amount at regular price by the elevator.

CANAL BOATS WHICH HAVE BEEN TOWED THROUGH THE ERIE CANAL AND HUDSON RIVER, IN THE EAST RIVER, NEW YORK CITY.

New York Fireboat.

After a lively competition among shipbuilders the City of New York placed with the New York Shipbuilding Company, Camden, N. J., an order for a fireboat for the Fire Department of the Boroughs of Manhattan and the Bronx.

The vessel is 117 feet over all, and other dimensions will be found in a table at the end of this article. The specifications call for a vessel complete in every respect, excepting the fire hose and nozzles and the cabin equipment. All steel used is to be open-hearth steel, and the material supplied is to be tested in accordance with the rules laid down by the American Shipmasters' Association. The bar keel is of extra-rolled bar iron 6 by 1 1-2 inches, worked in lengths of about 25 feet, with 18-inch scarfs. The stem is of 6 by 1 3-4-inch bar iron, rabbetted to receive the plating to about 4 feet below the water line.

The stern post is of cast steel, 6 by 3 1-2 inches, and the rudder post is 6 by 3 inches. The rudder is of forged iron, 5 inches at head, 2 1-2 inches at heel, and made in one piece with two arms. The weight is supported by three pintles and the plating is of 10 pounds, the space between being filled with white pine.

The tiller, with proper chains, is fitted upon the rudder stock below the level of the main deck.

The frames are 3 by 2 1-2 inch by 5 1-2-pound steel angles, spaced 20 inches, and scarf pieces 2 feet 6 inches in length are to be fitted across the line of keel back of floor plates on every frame. The reverse frames are 2 1-2 by 2 1-2 inch by 3 1-4-pound angles, extending alternately to the under side of the deck-beam bracket and to the upper stringer angle. The floors are 15 inches deep, of 12 1-2 pound plating, and under the engine extend to the engine seating, and under the boilers two floors to be extended to form saddles for same. A 9 by 4.4-inch by 23.4-pound I-beam forms the center keelson and is fastened to reverse frames with clips. The bilge keelson and hold stringer run as far forward and aft as practicable, and each is formed by a pair of 3 by 2 1-2 inch by 5 1-2-pound angles riveted to reverse frames and clips. At the forward end they are secured by gusset plates to the collision bulkhead. Over the engine and boiler foundation 12 1-2-pound intercostal plates, fastened by 3 by 2 1-2 inch by 4 1-2-pound clips, are worked between the floors.

The plating is worked in six in-and-out strakes. All

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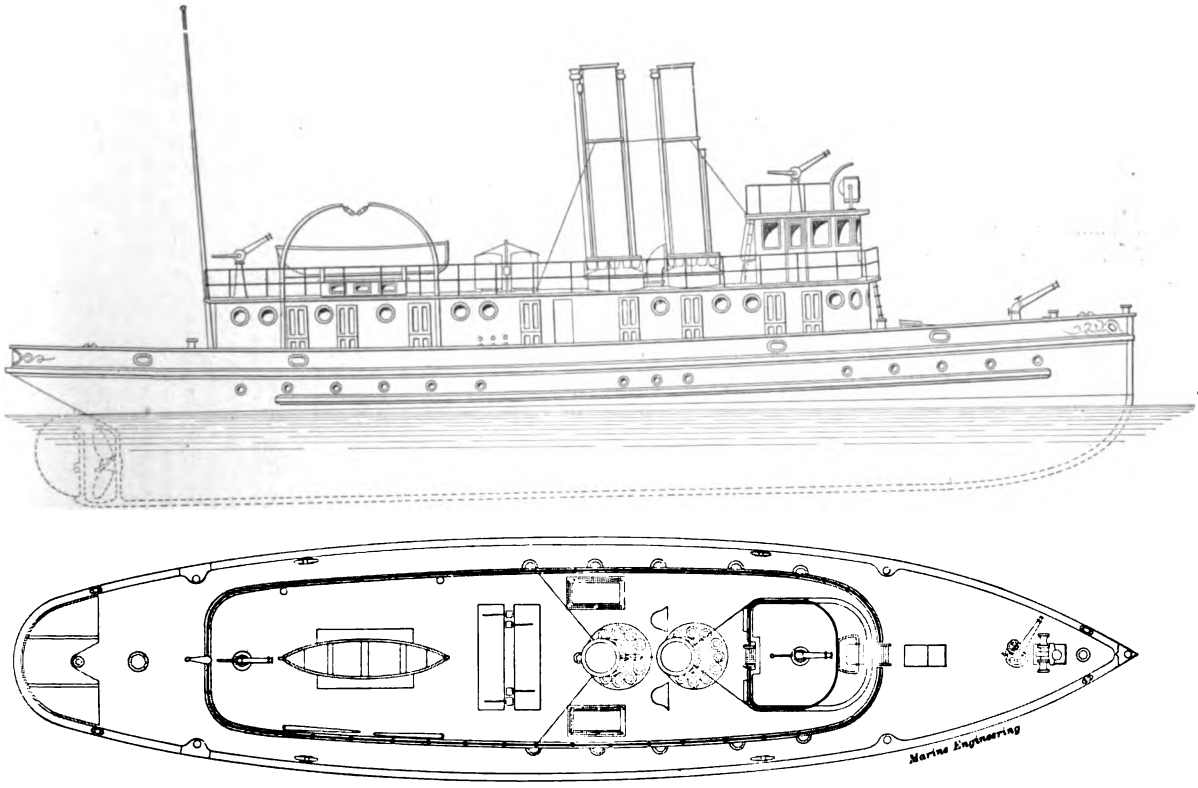
laps are single riveted, except the garboard which is double riveted. The butt straps are double riveted. The water-line strake at the bow is double plated for a distance of 10 feet from the stem. The garboard strake and sheer strakes for three-fifths length are 16 pounds; two-fifths of the sheer strake and three-fifths the length of the side and bilge strake are of 14 pounds; the remaining lengths of the side and bilge strakes are of 12-pound plates. The bulwarks are of 10-pound plating, supported by stanchions 1 1-2 inches in diameter. Three cast-iron scuppers and three freeing ports to drain the waterways are located on each side.

The deck beams are of bulb angles, 6 by 3 inches by 12.3 pounds, placed on alternate frames and to be fitted with welded knees. The crown is 6 inches in 24 feet. Where half beams are placed they are to be made of double angles, 3 by 2 1-2 inches by 5 1-2 pounds. The lower-deck beams are 3 by 2 1-2 inch by 4 1-2-pound angles. Hold stanchions are of 2-inch forged iron. The main-deck stringer plates, which are 21 inches by 11 pounds, tapering to 18 inches by 10 1-2 pounds, are to be worked on the main deck. The gunwale angles are 3 by 2 1-2 inches by 5 1-2 pounds, and the waterway angles 3 by 2 1-2 inches by 4 1-2 pounds. Four transverse bulkheads are fitted, the forward one water-tight and forming the forepeak, of 12 1-2-pound plating, the second of 7 1-2-pound plating, the third extending between the coal bunkers, of 7 1-2-pound plating, the fourth to be of 12 1-2-pound plating, forming the afterpeak tank. All bulkheads are properly stiffened. The wing coal bunkers are of 10-pound plating properly stiffened. The tops of the peak tanks are covered with 3-16-inch plate. A tank is constructed by extending the floor plate on the floor 10 feet forward of second bulkhead and plating back to bulkhead with 3-16 inch plate. All tanks are fitted with manholes and proper filling and draining valves, etc., and piping connected to a manifold.

The guards are to be two in number, the upper one of white oak 7 1-2 inches thick by 9 inches wide, to be carried from the stem along the gunwale round the stern; the lower guard is of white oak 6 inches thick by 5 1-2 inches wide. The upper one is stiffened by double 3 by 3 inch by 6.1-pound angles, and the lower by 3 by 2 1-2 inch by 5 1-2-pound angles. Chafing bands are to be worked on the outer edge of each guard. Hawse pipes are to be galvanized iron. The mooring bitts are to be placed four on each side, and two score chocks are to be located at the bow and two at the stern, made of composition. A "nigger-head" of galvanized cast iron, with composition cap, is to be placed at the stem, and there are four deck cleats of cast iron galvanized, two on each side. A galvanized hand windlass is securely bolted to forward deck plate. There are four coal scuttles and one ash scuttle on each side.



FIREBOAT DESIGNED BY H. DE B. PARSONS FOR THE CITY OF NEW YORK.

The main-deck planking is of selected white pine, 3 by 3 inches, laid parallel to gunwale.

The deck house is to be built, as shown in the plans, 7 feet high in the clear and plated with 8 1-2-pound steel, the framing to be of 2 1-2 by 2 1-2-inch by 4.2-pound angles. The house is to be attached to inside

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stringer by an angle 3 by 2 1-2 inches. The beams of the deck house and pilot house are of 3 by 2 1-2-inch by 4 1-2-pound angles. The house decks will be of white pine, 1 1-8 inches thick by 3 inches wide, covered with 10-ounce cotton canvas.

The rail is of clear, selected white oak, 10 inches wide by 3 inches thick, with rounded edges and bolted to angle bar. The pilot house is to be ceiled with sycamore. The forecastle will be fitted with ten folding galvanized iron berths; the port lights, numbering twenty-eight in all, are 10 inches in diameter in the clear.

There will be a steam steeering gear with small wheel, and also a hand gear with a larger wheel, so arranged that the hand gear can be easily thrown in when necessary. One 18-foot metallic lifeboat is to be supplied also anchor davit, boat davits, 300-pound folding anchor, necessary anchor chains, etc., to meet the government requirements. All living quarters are steam heated.

MACHINERY.

The propelling machinery consists of an inverted compound engine, with cylinders 17 and 34 inches in diameter by 22-inch stroke. Steam is supplied by two Scotch boilers of dimensions given in the table. The three pumps for fire service are supplied by the Fire Department, and are of the vertical, simple, duplex, flywheel, direct-acting type, two having steam cylinders 17 inches in diameter, water cylinders 10 inches in diameter, by a common stroke of 11 inches; the cylinders for the other pump being 9, 5 1-2 by 8 inches.

The high-pressure cylinder is fitted with a piston valve and the low-pressure with a double-ported balanced slide valve. The pistons are of cast iron, of the dished pattern, with cast-iron rings and springs. The engine is supported at the back by cast-iron columns fitted with crosshead slides, and the front columns, two in number, are of wrought iron. The bed plate is of box section cast iron and fitted with four main bearings. The condenser is of cast iron and forms part of the framing, and the tubes are of solid-drawn brass, tinned, 5-8 inch in diameter and No. 19 B.W.G. There is a steam reversing engine, which may be operated by hand. The air and circulating pump is of the Blake pattern, with one double-acting steam cylinder 16 inches in diameter, with two single-acting air cyclinders 12 inches in diameter with a stroke of 8 inches. The circulating pump, of the centrifugal type, has a capacity of 1,000 gallons per minute and will be driven by a 5 1-2 by 5-inch engine. The piston rod is of mild steel; the crosshead is of the same material with journals forged on and bolted to cast-iron shoe. The connecting rods are of steel, and the crank pins are 7 3-4 inches in diameter and 8 1-2 inches long. The crank shaft is of the built-up type; the thrust shaft is 7 1-4 inches in diameter and is to be fitted with six cast-iron horseshoe collars; the propeller shaft is to be of hammered iron, 7 inches in diameter, with a single composition casting shrunk on. The stern tube is of cast iron bushed with composition and fitted with lignum vitæ staves. The main steam piping is of seamless-drawn copper, 7 inches in diameter, with 5-inch branches to boilers and 5-inch branches to each large fire pump; exhaust pipe to be of copper, 11 inches in diameter. The suction and boiler-feed piping is also to be of copper.

A duplex bilge pump, 6, 4 by 7 inches, is to be connected to the bilge and water tanks. The feed pump will also be a duplex pump of the Blake or other approved type, with cylinders 6, 4 by 7 inches. An electric generator of 9 K.W. capacity will supply light throughout the vessel at 110 volts. There will also be located on the top of the pilot house a searchlight with an 18-inch projector.

Name.— **Nationality**—American. **Type**—Fireboat.
Launched.— **Owner**—New York City. **Builder**—New York Shipbuilding Co.

Length over all	117 ft.
" on water line	110 "
Beam, molded	24 " 3 1-2 ins.
Draft, load	9 " 6 "
Engines	one compound.
Cylinders diam.	17, 34 ins.
Stroke	22 "
Revolutions, estimated	150
H. P., guaranteed	500
Valves	piston, H. P.; slide, L. P.
Piston rods, diam.	4 ins.
Crossheads, wearing surf.	90 sq. ins.
Connecting rods, length	60 ins.
Crank pins	7 3-4 ins. diam. by 8 1-2 long.
Shafting, crank and thrust	7 1-4 ins.
Propeller shafting	7 ins.
Condenser, cooling surf.	1,150 sq. ft.
Propeller	Solid cast iron, four blades.
Diameter	7 ft. 6 ins.
Pitch	9 " 9 "
Boilers	two Scotch.
Diameter	10 ft. 9 ins.
Length	11 " 9 5-8 "
Pressure	140 lbs.
Furnaces	two Morison in each.
Diam., inside	40 ins.
Thickness	7-16 in.
Tubes, in each boiler	170
" of charcoal iron, No. 12 B. W. G.,	diam. 3 ins.
Stay tubes, thickness	1-4 in.

Refrigeration.—To cool and purify the air in ships' holds, an apparatus has been patented in England by C. W. Bollman by which the air is drawn from and returned to the hold after being cooled. The air is passed through a casing, where it is subjected to a spray of cooled brine from perforated pipes. Circulation of air is secured by a fan.

Cost of Government-Built Ships.—In the hope of lessening the expenses of the government in the contest with the Newport News Shipbuilding and Dry-Dock Company to determine whether it is possible to build warships at the navy yard as cheaply and quickly as a similar vessel is built bv a private firm, Rear Admiral Bowles has recommended to Secretary Moody that the men engaged on the battleship *Connecticut*, at the New York Navy Yard, be paid by piecework instead of by the day. In private yards a man works ten hours a day and is paid by piecework, while in the government yards he is paid by the day of eight hours.

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THE POWERING AND PROPULSION OF SMALL BOATS.

BY W. F. DURAND.

In the present chapter it will be our purpose to give some general discussion of methods for determining the amount of power required for the propulsion of small boats at such speeds as may be desired. The shape and proportions of the boat enter largely into the result, and the problem itself is so complex that, at best, no absolute rules can be given. In all such cases judgment must enter in very largely, and the most that can be done is to give some orderly procedure whereby judgment may be used to the best advantage with the material at one's disposal. For the purpose of this discussion we shall use the usual Admiralty horse-power formula in the following form:

$$H = \frac{A\,B}{K} \qquad (1)$$

in which H is the horse power required; the values of A, corresponding to the weight of the boat when fully loaded, is taken from Table I; that of B, corresponding to the speed in miles per hour, from Table II; and that of K selected by judgment, as discussed below.

TABLE I.—VALUES OF A.

Weight, pounds.	A	Weight, pounds.	A
500	.368	12,000	3.05
1,000	.584	13,000	3.23
1,500	.765	14,000	3.39
2,000	.927	15,000	3.53
3,000	1.21	16,000	3.71
4,000	1.47	17,000	3.86
5,000	1.71	18,000	4.01
6,000	1.93	19,000	4.16
7,000	2.13	20,000	4.30
8,000	2.33	21,000	4.44
9,000	2.53	22,000	4.58
10,000	2.71	23,000	4.72
11,000	2.88	24,000	4.86

TABLE II.—VALUES OF B.

Speed, miles.	B	Speed, miles.	B
5.0	125	11.5	1,521
5.5	166	12.0	1,728
6.0	216	12.5	1,953
6.5	275	13.0	2,197
7.0	343	13.5	2,460
7.5	422	14.0	2,744
8.0	512	14.5	3,049
8.5	614	15.0	3,375
9.0	729	15.5	3,724
9.5	857	16.0	4,096
10.0	1,000	16.5	4,492
10.5	1,158	17.0	4,913
11.0	1,331	17.5	5,359
		18.0	5,832

It may be noted that the values of A are found by taking the cube root of the square of the weight, reduced to tons of 2,240 pounds. Thus, for a total weight of 8,000 pounds we have 8,000 ÷ 2,240 pounds, or 3.57. The square of this is 12.74, and the cube root of this is 2.33, as noted in the table opposite 8,000. Other corresponding values may thus be found if desired. The values of B are also the cubes of the speed in miles per hour, and other or intermediate values may be found as desired. The values of K must be taken by judgment, guided by the following general indications: The value to be selected will depend chiefly on the three items, length, speed, and form. Other things being equal, it will be greater as the length is greater, less as the speed is greater, and greater as the form is finer; or, somewhat differently, its value will be less as the proportion of speed to length is greater, and as the form is fuller or proportion of beam to length is greater; and its value will be greater under opposite conditions. A short, wide, full form, at relatively high speed, would, therefore, call for the smallest values of K, or for relatively the largest values of H, as common-sense would tell us; while a relatively long, slender, fine form, at moderate speed, will call for relatively less power, and hence for a large value of K. As to what we mean by a speed relatively high or low in comparison with the length, there is no very definite rule. In general it will not be far wrong to consider any speed in miles per hour which is numerically less than the square root of the length of the boat in feet as relatively low, and *vice versa*. Thus, for a boat 25 feet long, 5 miles or anything less is relatively a low speed, while 6 and upward are relatively high; while again, for a fifty-foot boat, speeds of 7 or 8 miles are low, and those of 9 or 10 and upward relatively high.

The actual values for small craft such as we are now considering, and at ordinary full speeds, are usually from 150 to 225 or upward. For large-sized ships, at moderate speeds, the values are much larger, rising to 400 and over in special cases. It should be noted that these values refer to speed expressed in miles per hour, as is common in discussing small boats. If the speed is expressed in knots, the values for small boats would become reduced to 100 to 150, rising to 200 and upward to 300 or more for large ships in special cases.

In illustration of the above suggestions we may assume a boat of 50 feet length at 7 miles per hour. Here the speed is moderate and a value of 225 would not be unreasonable. As this speed is exceeded, however, the corresponding value of K should decrease in order to provide for relatively greater power, and with a form of moderate fineness may be expected to come down to somewhere about 150 for a speed about twice the square root of the length in feet, or at 14 to 15 miles. For a 25-foot boat the corresponding speeds would be 5 and 10 miles respectively.

The influence of form on this value, as referred to above, must also be borne in mind. The two chief aspects are the relation of length to beam and the degree of longitudinal fullness. The narrower the boat for the length, and the finer the form longitudinally, the greater the value of K, and *vice versa*.

We must next note the relation between the dimensions of the boat and the probable displacement or total weight, as referred to in Table I. The actual volume of water displaced will be a certain fraction of the box formed on the chief dimensions, length, beam, and draft. This fraction is known as the block coefficient. Its value is usually found between .40 and .60 or .65 for boats of the type we are now considering. The lower value .4 would correspond to a fine-lined racing launch, while the larger values would correspond to fuller boats, in which comfort and capacity are of more importance than speed. Values of .55 to .60 are quite common in construction of this character. Then, remembering that sea water weighs 64 pounds per cubic foot and fresh water 62.5 pounds, the total displacement

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in pounds is readily found from the estimate of the volume thus made.

A few illustrative examples will serve to show the method of applying these principles to the determination of displacement and power.

Suppose length 25 feet, beam 5 feet, and mean draft 2 feet in salt water, with a fairly full form. A speed of about 8 miles per hour is desired. What power should be provided?

Taking the block coefficient at .65, we have for the volume of the under-water body $25 \times 5 \times 2 \times .65 = 162.5$. Multiply this by 64 and we have for the weight $64 \times 162.5 = 10{,}400$ pounds. Taking the value of K at 180 for this case, and the corresponding values of A and B from the tables, we have:

$H = 2.78 \times 512 \div 180 = 7.9$, or, say, 8 horse power.

Again, take length = 20 feet, beam 5 feet, mean draft 18 inches in fresh water, speed 6.5 miles per hour. Take the block coefficient the same as above, and we have for the probable displacement, $20 \times 5 \times 1.5 \times .65 = 97.5$ cubic feet. Multiply this by 62.5 and we have 6,094 pounds. Taking the same value of K as above gives:

$H = 1.95 \times 275 \div 180 = 2.98$, or 3 horse power.

Again, take length = 40 feet, beam 5 feet 6 inches, mean draft 2 feet 6 inches in salt water, speed 12 miles per hour. Assuming that this is a boat built for speed and with a finer form than those above, we may take the block coefficient at .45. Then for the displacement we have: $40 \times 5.5 \times 2.5 \times .45 = 247.5$ cubic feet. This multiplied by 64 gives 15,840 pounds.

For this case, taking $K = 210$, we have:

$H = 3.68 \times 1{,}728 \div 210 = 30.3$, or about 30 H. P.

While there will be need for the exercise of much judgment based on experience, the foregoing suggestions will at least serve to give a reasonably close approximation to the power which should be supplied in any case likely to arise in ordinary experience.

DESIGN OF PROPELLER.

This problem is, if anything, still more complicated than that of determining the necessary power, as discussed above. We shall give, however, a relatively simple procedure from which satisfactory results may be obtained in all ordinary cases.

Let d = diameter in feet.
p = pitch in feet.
N = revolutions per minute.
H = horse power.
u = speed in nautical miles per hour.
K = coefficient taken from Table III, in accordance with the pitch ratio or value of $p \div d$.

Then we have the following equations:

$$d = K \sqrt{\frac{H}{u^3}}$$

$$pN = 117\, u.$$

TABLE III.

Pitch Ratio.	K
1.0	12.8
1.1	13.6
1.2	14.3
1.3	15.1
1.4	15.8
1.5	16.6
1.6	17.3
1.7	18.0
1.8	18.8

These values are intended primarily for a four-bladed wheel, with generally oval blades, the total blade area being from .36 to .45 of the disk area or of the area of the circle $\pi d^2 \div 4$. Values of d less than those given by the equation should not be adopted unless necessary. If, however, the available room will not admit the diameter thus found, it may, with some sacrifice of efficiency, be reduced, and with it the other features of the wheel proportionately, to an amount which should not exceed 15 to 20 per cent., while correspondingly it may be expected that the slip will increase and with it the value of pN by about 10 per cent., the decrease of d and increase of pN keeping relative step, the latter being somewhere about one-half the former.

Furthermore, to use these results for *two* or *three* blades instead of *four*, the following relations may be observed:

For two blades, other things being equal, the diameter found as above should be increased by about 20 per cent., or one-fifth.

For three blades, other things being equal, the diameter found as above should be increased by about 10 per cent., or one-tenth.

The use of these equations may best be illustrated by a series of examples.

Taking first example 1 above, we have $H = 8$ and $u = 8$. We will try first a pitch ratio of 1.2. Then we have:

$d = 14.3 \sqrt{\frac{8}{512}} = 1.8$ feet $= 21.6$ inches.

$p = 1.8 \times 1.2 = 2.16$ feet $= 25.9$ inches.

$pN = 936$.

$N = 936 \div 2.16 = 433$.

It is quite likely that this value of N may be considered too high. In such case we must choose a larger pitch ratio. Taking, therefore, a value 1.3 for further trial, we find similarly:

$d = 1.89$ feet $= 22.7$ inches.
$p = 2.46$ feet $= 29.5$ inches.
$N = 380$.

Suppose in this case, however, a two-bladed wheel is desired. Then the diameter should be increased by about one-fifth, or to about 2.27 feet. We should then have:

$d = 2.27$ feet $= 27.2$ inches.
$p = 2.95$ feet $= 35.4$ inches.
$N = 317$.

In such case it is quite likely that the lower pitch ratio 1.2 would be more appropriate, and taking our results for that ratio and enlarging d to correspond to a two-bladed wheel, we find as follows:

$d = 2.16$ feet $= 25.9$ inches.
$p = 2.59$ feet $= 31.1$ inches.
$N = 361$.

Take next the second boat assumed for illustration at an earlier point, and we have $H = 3$, $u = 6.5$. Taking on trial pitch ratio = 1.3, we find as follows:

$d = 1.58$ feet $= 19$ inches.
$p = 2.05$ feet $= 24.6$ inches.
$pN = 760$.
$N = 371$.

If, on the other hand, this is to be a two-bladed wheel, the values will result as follows:

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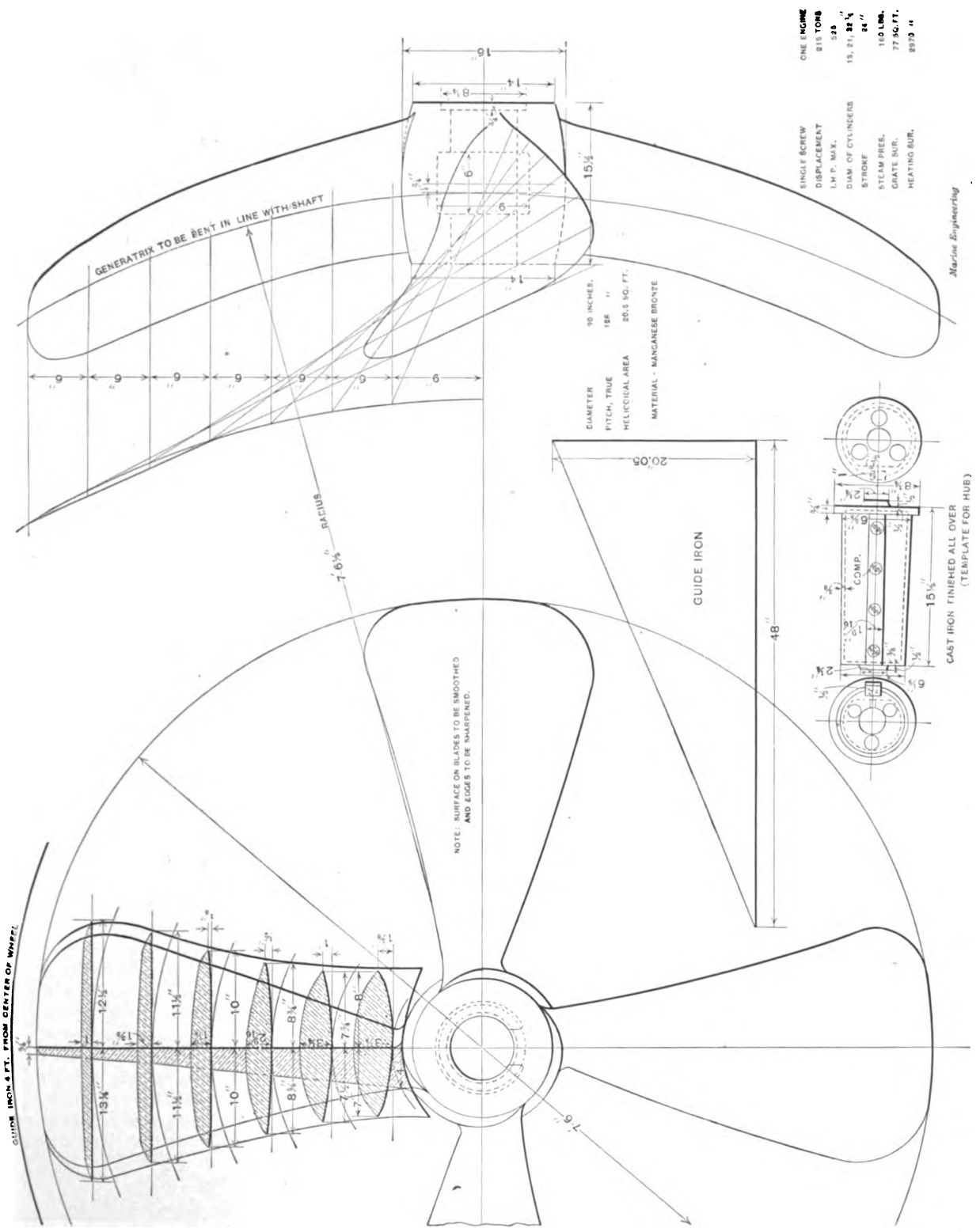

FOUR-BLADED PROPELLER.

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$d = 2.05$ feet $= 24.6$ inches.
$p = 2.66$ feet $= 32$ inches.
$N = 286$.

We may do something better with a pitch ratio 1.2, for which we find values as follows:

$d = 1.79$ feet $= 21.5$ inches.
$p = 2.15$ feet $= 25.8$ inches.
$N = 354$.

Suppose in this last case that it were desired to reduce the diameter somewhat, even at the expense of some propulsive efficiency. Let us then reduce the diameter to, say, 1.6 feet $= 19.2$ inches. This is a reduction of about 11 per cent., and would probably cause an increase of about 6 per cent. in the value of pN. We should then have results as follows:

$d = 1.6$ feet $= 19.2$ inches.
$p = 1.92$ feet $= 23$ inches.
$pN = 805$.
$N = 419$.

As a final example let us take the third boat assumed above. We have in this case $H = 30$, $u = 12$. Taking again as a first trial pitch ratio $= 1.5$, we find:

$d = 2.19$ feet $= 26.3$ inches.
$p = 3.29$ feet $= 39.5$ inches.
$pN = 1404$.
$N = 427$.

If this value of N is considered too high, as might be the case with engines of this power, we must take a still larger value of the pitch ratio. Thus for 1.6 we find as follows:

$d = 2.28$ feet $= 27.4$ inches.
$p = 3.65$ feet $= 43.8$ inches.
$N = 385$.

While for a value 1.7 we should find as follows:

$d = 2.37 = 28.4$ inches.
$p = 4.03 = 48.4$ inches.
$N = 348$.

These might be further modified for 2 or 3 blades, or for decrease of diameter with increase of slip and greater values of pN, and other examples might be given; but the preceding should be sufficient to illustrate the method as applied to the types of cases most commonly met with in connection with boats of the character under present discussion.

FORMS OF PROPELLERS.

In the preceding section relating to the design of propellers we have referred to the form simply as determined by the number of blades and by the generally oval form of the blade contour. In the present section we wish to give somewhat more detailed reference to the question of form and to the propeller as an engineering structure.

A screw propeller may be defined as a series of blades having on the rear or driving face an approximately helicoidal surface, such blades being secured to a common hub through which they are joined together and receive their motion of revolution from the shaft on which the hub is mounted. It follows that the blades in effect constitute the propeller, and upon their form and dimensions depends the entire performance of the propeller as an instrument of propulsion.

For our present purposes we may define a helicoidal surface as one generated by a straight line revolving about an axis at right angles to it, and moving its point of contact along the axis at the same time. It is in effect the same kind of surface as that which is found on the sides or flanks of a square-screw thread, as on the lead screw of a lathe. The face of a propeller blade is thus similar to a small fraction of a turn of a very deep screw thread, and this, with the thickness laid on, constitutes the blade itself. The propeller is then made up of two, three, or four such blades. The propeller blade, thus defined, is the simplest possible in form, producing the so-called true screw or uniform-pitch propeller with blades at right angles to the axis. The blades may, however, be bent or curved back somewhat, by a suitable modification of the generating line, and various modifications may be introduced into the form of the blade, all without changing its character as a true screw or propeller of uniform pitch.

The pitch, from the analogy to the screw thread, is defined as the distance axially between two successive turns of the same helicoidal surface, or the distance which the screw would propel the boat providing it were supported on a corresponding immovable helicoidal surface, as that of a nut of equal pitch and suitable form.

The faces of many propellers, however, are so formed that the pitch is not the same at all parts of the surface. That is, the entire blade face does not belong to one helicoidal surface, as defined above, and the actual blade face could not be generated by a line in the manner indicated above. In some cases the faces of such variable-pitch propellers may be generated by a line and in others they cannot be so formed. The simplest general way in which to consider the face of a propeller of variable pitch is as a combination of a series of helicoidal elements, each of which belongs to some surface as above defined, and for each of which there is a definite pitch, as resulting from such definition. The most common variation of pitch is axial or a gradual increase from the forward or leading edge of the blade to the after or following edge. In addition, variation from the hub to the tip is often found with or without increase axially, as above noted.

There seems to be no experimental evidence justifying the use of a variable pitch, and, so far as experience can show, the propeller of uniform pitch may be depended upon as the equal of any fanciful variation of pitch which has yet been suggested or employed.

The shape of the blade should be oval or well rounded at the tip. If the diameter has been reduced below the values indicated by the equations given in the preceding section, the form may be filled in or widened somewhat at the tips, but in all cases the corners should be well rounded off, with as nearly as may be a smooth and continuously-curved contour of blade.

BLADE AREA.

The area of the circle $\pi d^2 \div 4$, that is, the area of the circle swept by the tips of the blades, is commonly called the disk area. The actual blade area is usually proportioned to the disk area, and, in accordance with the rules given for four-bladed propellers in the preceding section, its amount is usually from .35 to .45 of such area. For a three-bladed wheel its amount will usually be found from .27 to .33 of the disk area, while

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for a two-bladed wheel the fraction will vary from .20 to .25. In other words, each blade, as a rule, may be given from .09 to about .12 of the disk area, the larger blades being the more permissible on the two- and three-bladed wheels. Experiment indicates that there is little or no use in continuing the addition of area beyond a certain point. With propellers of low pitch ratio, such as those from 1.0 to 1.2, no advantage can be looked for from an area beyond .40 to .45 of the disk area. As the pitch ratio rises, however, more and more area may be added with the expectation of some slight gain, but in no ordinary case will it be desirable to go much beyond .45 or .48 of the disk area.

MATERIALS.

Cast iron, ordinary brass, and bronze are all employed for propellers, as well as cast steel for those of large size. Cast iron is the cheapest, but it is relatively weak and brittle and the thickness of the section must be relatively large, and the edges cannot be made as thin as with brass or bronze. Brass gives a smoother surface and sharper edges, but does not allow any material reduction in the thickness. Bronze of high quality is the best material for propeller blades, giving a smooth surface, sharp thin edge, and reduced thickness, all of which are favorable to good efficiency. Of the various high-grade bronzes manganese bronze is usually preferred, and may be considered as the most desirable material for all high-grade work.

For an estimate of the actual thickness of the blade at the root, or where it joins the hub, we may use the formula:

$$t = A\sqrt{\frac{H}{b\,N\,n}}$$

where t = thickness in inches at root of blade.
H = horse power.
b = breadth of blade in inches at root.
N = revolutions per minute.
n = number of blades.
A = 13 to 16 for bronze and
18 to 20 for cast-iron or common brass.

Thus, for illustration, suppose $H = 8$, $N = 380$, $n = 4$, and $b = 4$. Then we have for cast iron or common brass, taking $A = 18$,

$$t = 18\sqrt{\frac{8}{4 \times 380 \times 4}} = .65 \text{ inch.}$$

For bronze we might have similarly

$$t = 15\sqrt{\frac{8}{4 \times 380 \times 4}} = .54 \text{ inch.}$$

REVERSING THE PROPELLER OF A MOTOR BOAT.

When the propeller is driven by a steam engine the steam is controlled by some form of reversing valve gear through which the engine is reversed without difficulty. With the usual type of gasoline engine, however, the operation, as elsewhere seen, is entirely different in character, and such an engine cannot be reversed in the same way as a steam engine.

In some cases, especially in small sizes, the sparking device may be so adjusted as to admit of starting the engine in either direction once it is stopped. In such cases the engine may, therefore, be reversed, and a propeller wheel of the usual type may be employed.

In the more usual case, however, the engine is intended to run in one direction only, and for reversing the propeller some means other than reversing the engine must be provided. To this end two means are available: A reversing mechanism is placed on the shaft, or the propeller itself is of the reversible type.

While the principle involved may be worked out in a variety of ways, it consists essentially of a bundle of gear wheels and friction clutches so connected that when thrown into the go-ahead position the whole mechanism is locked and acts as a form of rigid coupling connecting the engine with the propeller shaft, which therefore turns with the engine in the usual manner. When, on the other hand, it is thrown into the backing position the connection from the engine shaft to the propeller shaft is through the gearing, and in such way that the motion is reversed, so that in this way the engine may be allowed to turn continuously in one direction, while by means of a control lever the clutch may be thrown into the ahead or backing position, or, if desired, into an intermediate position where the engine shaft revolves freely without attachment to the propeller shaft, which, therefore, remains at rest.

In the case of the reversing propeller the shaft is continuous, or at least may be so, and the reverse is brought about by changing the obliquity of the blades of the propeller. The blades are each cast separate and mounted on the hub on a pivot in the center line of the blade. A lug or pin or some portion of the blade then extends into the hub, where it is attached to a rod carried through the hollow propeller shaft or otherwise to a control lever located in a convenient position for operation at the engine. In order to avoid complication such propellers are rarely made with more than two blades, though in one form three blades have been employed.

With this device the blades may be held in their usual position for go ahead, or thrown over to the opposite position for backing, or held in an intermediate position where the effective pitch of the blades is nothing, and where the boat will remain at rest or slowly forge ahead or back as the angle may be inclined one way or the other.

In regard to the change of pitch in this manner, it must be noted, however, that only in the one position for which the blades are originally intended will the faces lie in a true helicoidal surface. In all other positions the pitch will vary over the face of the blade; and while there will be some resultant or effective value, still operation at this setting will be at a sacrifice of efficiency. Such propellers should, therefore, be so designed and proportioned as to allow of operation for normal conditions in the setting which gives the true helicoidal surface for which the blades are primarily designed.

Regarding the choice of propeller it is probably fair to say that where propulsive efficiency is of importance a four-blade solid wheel may be recommended, and this with the usual type of gasoline engine will require a reverse mechanism in the shaft. In many cases, however, with boats of this type, the highest attainable propulsive efficiency is a matter of less importance than compactness or handiness of manipulation, and from these points of view some may prefer the reversing propeller to the reversing clutch. Either type of arrange-

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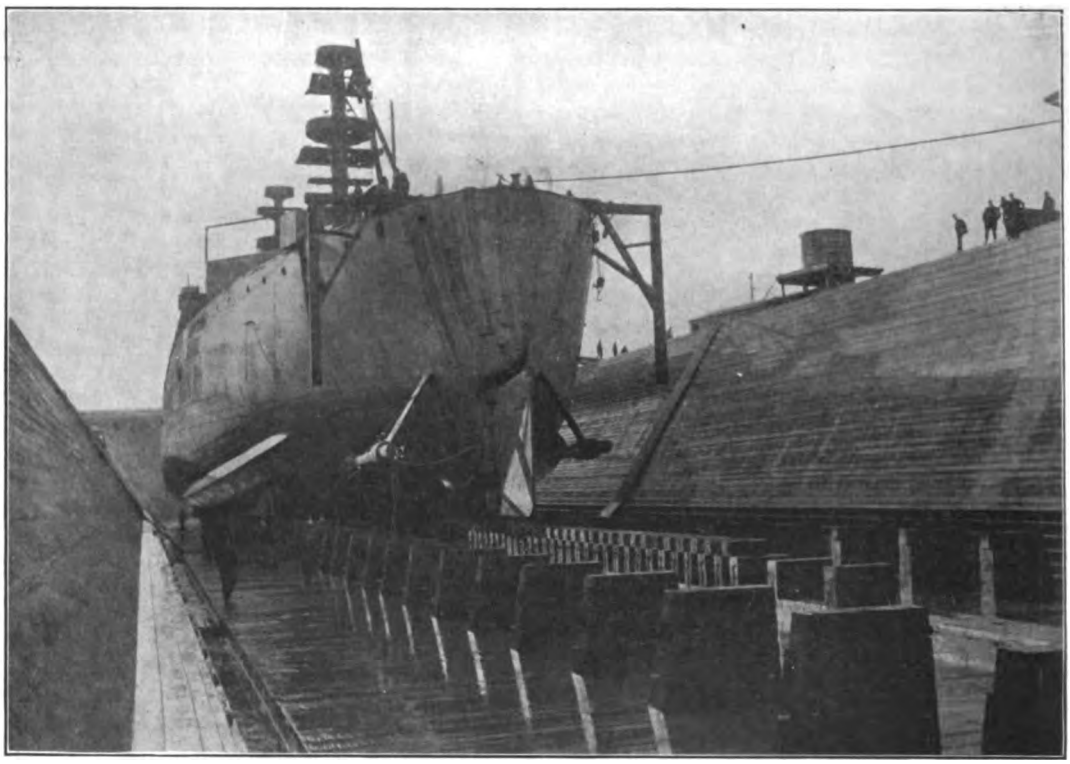
ment provides a satisfactory mechanical solution of the problem of reversing the motion of the boat, and each is well represented by several different types of such mechanism in use in the practical field.

It is not expected that these remarks on propeller design for small boats will enable the amateur to confidently undertake all cases of such design with which he may come in contact, but they should serve at least to give indications of the lines along which his studies must be directed, and will be found, if intelligently applied, to give reasonably satisfactory results in all ordinary cases. An attempt to introduce a more detailed analysis of the problem, or to provide a method of design which should include in greater detail the influence of the various factors, would have resulted in methods unsuited to the purposes for which these chapters have been prepared.



STERN VIEW OF BATTLESHIP OHIO IN HUNTER'S POINT DRY-DOCK.

The Battleship Ohio in Hunter's Point Dry-Dock.

Two years ago the San Francisco Dry-Dock Company began the construction of a dry-dock at Hunter's Point, San Francisco harbor. The dock was completed in January of this year and was formally opened on January 29 to receive the hull of the United States battleship *Ohio*, which was launched by the late President McKinley, and has been under construction for nearly three years at the Union Iron Works.

The new dock was described in MARINE ENGINEERING of August, 1902, and, it will be remembered, is of the following dimensions: 750 feet long, 122 feet wide at top and sloping down to 80 feet wide at the level of the top of keel blocks. At high tide there are 28 feet of water over the sill, and thus the largest vessel afloat could be dry-docked comfortably in this basin. The *Ohio* is 93 feet long by 72.2 feet beam, but at the time of docking drew only 17 feet of water with a displacement of 8,000 tons. She was towed from her moorings at the Union Iron Works by the tugs *Sea Rover, Sea Fox,* and *Sea Queen* and brought to Hunter's Point; at 11.40 A.M. the great caisson was floated away from the entrance of the dock and the battleship was warped inside the gate. The gate was then floated back, sunk in place, and at 12.45 P.M. the three centrifugal pumps, each with a capacity of 40,000 gallons of water per minute, started to discharge the water from the dock. At 2.50 P.M. the battleship was resting on the keel blocks and the dock clear of water. As the receding water exposed the hull of the vessel, an army of laborers attacked the barnacles and sea plants on the ship's bottom, and by the time all the water was out of the dock the hull was clean. Though the ship had not been docked for ten months, her bottom was not very foul.

As she entered the dock there were 11 feet of water between her keel and the sill of the dock; as she lay in the dock after the water had been pumped out, there were four feet to spare on each side of her at the narrowest part of the dock; and between her stern and the gate there was an unoccupied space of 357 feet.

Steamer Tionesta.—The Erie and Western Transportation Company's new steamship *Tionesta,* which will go into commission in the Anchor Line fleet this spring, was launched on December 15 from the Wyandotte yards of the American Shipbuilding Company. The vessel is 360 feet long over all and has a cargo capacity of 3,500 tons and passenger accommodations for 350.

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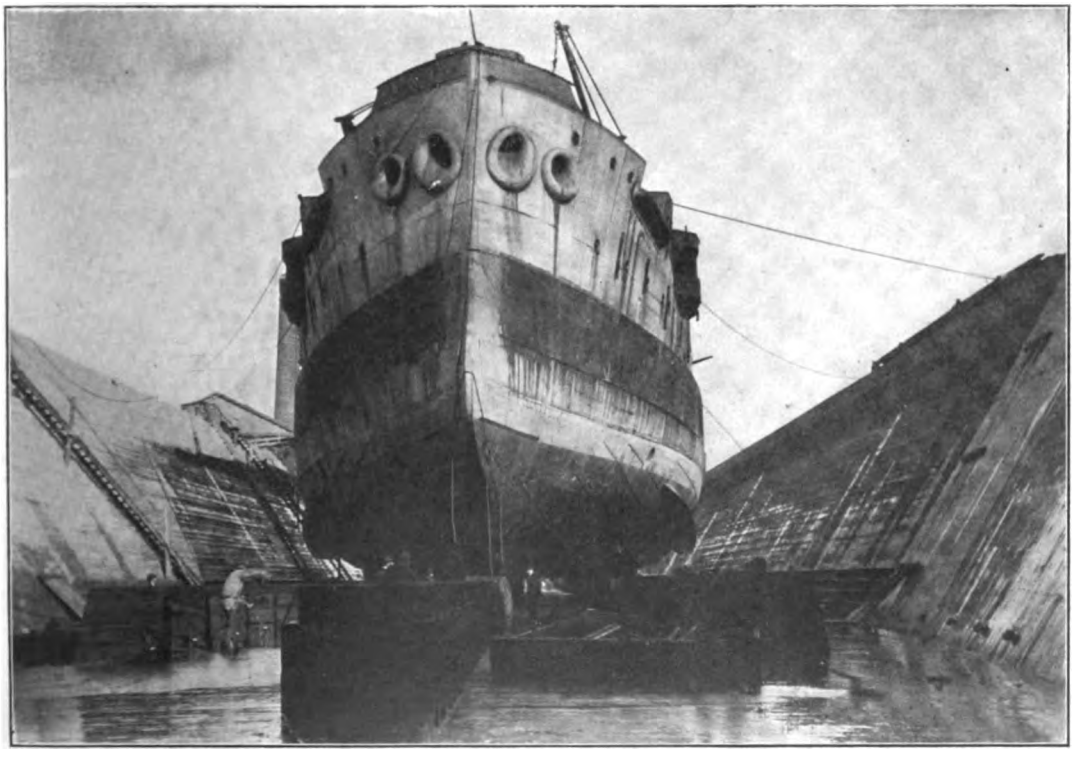
DOCKING THE BATTLESHIP OHIO AT HUNTER'S POINT.



BOW OF THE BATTLESHIP OHIO.

[Photographed by P. F. Dana.]

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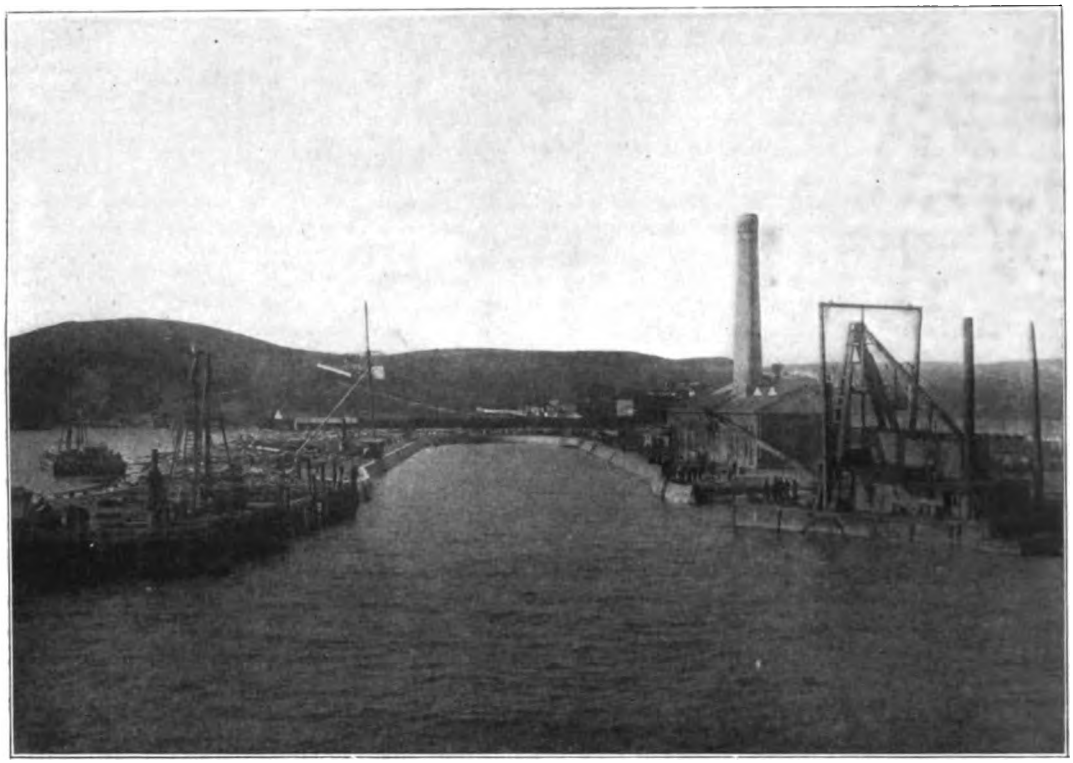
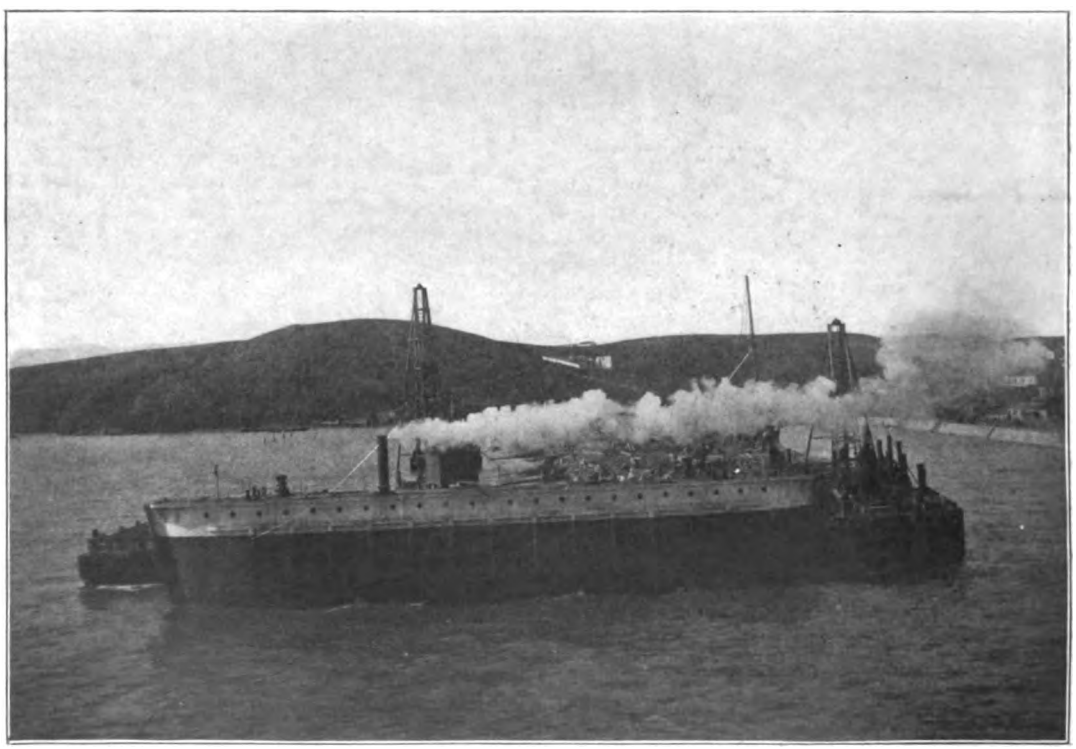


NEW DRY-DOCK AT HUNTER'S POINT, SAN FRANCISCO HARBOR.



STEEL CAISSON OF THE HUNTER'S POINT DRY-DOCK.

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Safety Valves.

BY H. K. SPENCER, U. S. R. C. S.

There are numbers of different rules for determining the size of safety valve necessary for a given boiler, and it is to be expected that there would be some difference in the results obtained, even though they are all good and general in their application, but there ought not to be the wide difference there actually is. It may be that some of the rules are not published as those who devised them intended they should be, and some may have been devised for certain conditions only, but, when no conditions are stated, we assume the rules to be general.

A safety valve, to fulfill its purpose, must be of a size sufficient to discharge all the steam made by the boiler when steaming at its full capacity, and it need be no larger. The area through which the steam is discharged is a cylindrical one, and is the product of the circumference of the valve and its lift; so the discharging capacity of a valve varies as its circumference, not its area, that is, as the diameter, not the square of the diameter. This is true until the valve has been raised to a height equal to one-fourth of its diameter, when the cylindrical area equals the area of the valve, after which, no matter how high the valve is raised, the discharging capacity remains constant and is measured by the area of the valve.

Thus the area of valve $= 1\text{-}4\,\pi d^2$, circumference of valve $= \pi d$, and when the lift is made equal to $1\text{-}4d$ the area of the cylindrical opening is $\pi d \times 1\text{-}4d = 1\text{-}4\,\pi d^2$.

The velocity of escaping steam is practically constant at all ordinary pressures, so the weight of steam discharged through a given orifice in any given time depends upon the pressure only because the density varies as the pressure. It is for this reason that safety valves are designed for the pressure at which the boiler will be worked when old. In what follows, it will be assumed that each pound of coal burned on the grates will evaporate 8 pounds of water, a figure undoubtedly large, The rate of combustion for natural draft will be determined by the rule $c = 3\sqrt{H}$, where c = coal in pounds per hour burned per square foot of grate, and H = height of smokestack in feet above lowest grates.

The discharging capacity necessary for a safety valve is expressed by the equation,

$$W = w \times A,$$

where W is the total weight of water evaporated per hour, and is consequently equal to the weight of steam which the safety valve must be able to discharge in one hour;

w is the weight of steam, in pounds, discharged per hour per square inch of orifice, through an opening similar to a safety opening, and is obtained from the equation, $w = 45 \times P$, P being the absolute steam pressure in pounds;

A is the cylindrical area in square inches, which is the actual area through which the steam is discharged.

The following additional notation will be used:

A_1 = area of safety valve in square inches;
d = diameter of valve in inches;
p = gage pressure in pounds;
H.S. = heating surface in square feet;
G.S. = grate surface in square feet;
C = total coal burned per hour in pounds and $= c \times$ G.S.;
a = area of high-pressure piston in square inches;
V = velocity of piston in feet per minute.

Some of the published rules are applied in two cases where the writer has the necessary boiler data. The boilers will be designated as No. 1 and No. 2. Boiler No. 1 is comparatively old, having been built about eighteen years ago; it is now worked at a pressure of 65 pounds, and is fitted with one spring-loaded safety valve. No. 2 is new, and though at present its working pressure is 160 pounds, it is assumed that the boiler will be worked at a pressure of 140 pounds when old, and the necessary safety-valve area is calculated for that pressure. This boiler is fitted with two safety valves on a single base. Both are marine boilers of the ordinary Scotch type. The boiler data are:

	No. 1.	No. 2.
Heating surface, sq. ft	1,700	1,300
Grate surface, sq. ft	63	45.5
Height of stack, ft	45	54
Working pressure, lbs	65	160
Diameter high-pressure piston, in	26	25
Piston speed, ft. per minute	600	800
Number of safety valves	1	2
Diameter of each valve, in	5	2.75

The size of safety valve given for No. 2 boiler is that for one of the two valves with which it is fitted, and, except in one case, is that of a valve of half the capacity of the one obtained by rule. The diameter of valve is given for convenience of comparison..

The lift of the valve, in any case, may be called L.

No.	Authority.	Rule.	Boiler. No. 1.	Boiler. No 2.
1	Rankine	$A = \frac{H.S.}{3p}$	6.71 ins.	2.98 ins.
2	Rankine	$A_1 = .006\ W$	8.78 "	5.53 "
3	U. S. Inspectors	$A_1 = \frac{G.S.}{3}$	5.17 "	3.11 "
4	Prussian Law	$A_1 = \frac{36\ G.S.}{p}$	6.66 "	2.73 "
5	Philadelphia Inspection Law	$A_1 = \frac{2.25\ G.S.}{p+8.62}$	4.96 "	2.10 "
6	Unknown	$A_1 = \frac{.5\ W}{p+10}$	0.26 "	4.12 "
7	Inst. Eng's and Shipbuilders in Scotland. 2 valves size found by this rule	$A_1 = \frac{.6\ H.S.}{p}$	6.32 " *	2.66 "
8	Hutton's Steam Boiler Construction	$A_1 = \frac{4\ G.S.}{p}$	6.31 "	3.13 "
9	Hutton's Steam Boiler Construction	$A_1 = \frac{W}{40\sqrt{p}}$	6.31 "	3.26 "
10	Bourne	$A_1 = \frac{aV}{300\ P}$	4.12 "	2.32 "
11	Unknown	$A_1 = \frac{C}{30}$	7.32 "	4.61 "

* Size of single valve equal to combined area of two valves obtained by this rule.

When using rule No. 1, L is supposed to be at least equal to $\frac{d}{20}$, and in rule No. 4, at least equal to $\frac{d}{36}$.

An inspection of the results tabulated above shows the extent of the variation, and also that the rule which gives the largest valve for boiler No. 1 does not give

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the largest size for No. 2; so also for the smaller sizes. Applying the formula, $w = 45\ P$, it gives for boiler No. 1, $w = 45 \times 80 = 3{,}600$ pounds per hour per square inch of safety-valve opening, as the rate at which the steam would be discharged from that boiler.

For boiler No. 2 the rate is 6,975 pounds per hour per square inch of safety opening.

By the law governing the Steamboat Inspection Service of the United States, it is required that "each spring-loaded safety valve shall be supplied with a lever that will raise the valve from its seat to a distance of not less than that equal to one-eighth of the diameter of the valve opening," so, in calculating the maximum discharging capacity of a safety valve, its lift may be taken as $\frac{d}{8}$. The lift, L, of any safety valve, due to the action of the escaping steam, even when blowing off with the boiler steaming at its full power, is generally considered to be about $\frac{d}{24}$, so that will be taken as the lift of the valve when discharging automatically, and in calculating what can be termed the minimum rate of discharge.

		No. 1.		No. 2.
Maximum discharging capacity largest in pounds steam per hour when $L = \frac{d}{8}$	Rule 6.	121,200	Rule 2.	167,500
Rate in pounds coal per hour per sq. ft. grate at which boiler can be fired and largest valve discharge all steam made, with $L = \frac{d}{8}$	Rule 6.	240	Rule 2.	460
Maximum discharging capacity largest valve in pounds per hour, $L = \frac{d}{24}$	Rule 6.	40,400	Rule 2.	55,820
Rate in pounds coal per hour per sq. ft. grate at which boiler can be fired and largest valve dispose of all steam made, $L = \frac{d}{24}$	Rule 6.	80	Rule 2.	153
Maximum discharging capacity smallest in pounds steam per hour, $L = \frac{d}{8}$	Rule 6.	23,990	Rule 2.	21,260
Rate in pounds coal per hour per sq. ft. grate at which boiler can be fired and smallest valve dispose of all steam made, $L = \frac{d}{8}$	Rule 10.	47.6	Rule 5.	58.4
Minimum discharging capacity smallest valve in pounds steam per hour, $L = \frac{d}{24}$	Rule 10.	7,980	Rule 5.	7,090
Rate in pounds coal per hour per sq. ft. grate at which boiler can be fired and smallest valve dispose of all steam, $L = \frac{d}{24}$	Rule 10.	15 8	Rule 5.	19.5
Discharging capacity actual valve in pounds steam per hour, $L = \frac{d}{8}$	Rule 10.	35,350	Rule 5.	41,440
Combustion rate permissible, actual valve open $\frac{d}{8}$, in pounds coal per hour	Rule 10.	70.4	Rule 5.	113.8
Discharging capacity actual valve in pounds steam per hour, $L = \frac{d}{24}$	Rule 10.	11,780	Rule 5.	13,800
Combustion rate permissible, actual valve open $\frac{d}{24}$, in pounds coal per sq. ft. grate	Rule 10.	23 5	Rule 5.	37.9

It is seen from an inspection of the above figures that the largest valves are very much in excess of any possible requirement, even when discharging automatically, while the smallest valves, when discharging automatically, are sufficient only for moderate rates of combustion. The actual valves seem to be about what is required, a little large, perhaps, for both boilers. No. 1 is always worked under natural draft, while No. 2 is sometimes worked under moderate forced draft.

The size of the safety valve should be determined only from the amount of steam the boiler can produce when fired with the greatest amount of coal that can be burned on the grates. With natural draft the maximum combustion rate is about 25 pounds coal per hour per square foot of grate, and with forced draft 50 pounds is about the limit, torpedo boats excepted. It should be understood that the higher the rate of combustion the lower the rate of evaporation; the figure, 8 pounds water evaporated per pound of coal, is good work for a moderate rate of combustion, and it would be nearer the fact to say that, with forced draft, when burning 40 to 50 pounds of coal per hour per square foot of grate, 6 pounds of water are evaporated per pound of coal. It is seen that the rate of combustion is most variable, and that the rate of evaporation is also variable in a less degree, so the best way to approximate the generating power of the boiler is by means of the maximum I.H.P. of the engine. The steam consumption of any ordinary type of engine can be predicted with fair accuracy; 17 pounds per I.H.P. per hour for triple-expansion engines, 19 pounds for compounds, and 25 pounds for simple condensing engines can be called average figures. The maximum quantity of steam required of a boiler furnishing steam to a triple-expansion engine, then, is 17 × I.H.P., which quantity of steam the safety valve must be capable of discharging; that is, the product of the area of the actual valve opening, A, and the rate in pounds per hour per square inch of valve opening at which the steam is discharged, must equal 17 × I.H.P., or,

$$A \times 45\ P = 17 \times I.H.P.$$

Assuming the lift of the valve to be $\frac{d}{24}$,

$A = \frac{\pi d^2}{24}$; now $A_1 = \frac{\pi d^2}{4}$, so $A = \frac{A_1}{6}$, and then,

$A = \frac{2.27\ \text{I. H. P.}}{P}$ for the area of the safety valve for a boiler furnishing steam to a triple-expansion engine.

In the same way, for a boiler furnishing steam for a compound,

$$A = \frac{2.54\ \text{I. H. P.}}{P}$$

For one furnishing steam to a simple engine,

$$A = \frac{3.33\ \text{I. H. P.}}{P}$$

Valves over 5 inches in diameter are seldom employed, especially with high pressures. The necessary area should be obtained, if a valve over 5 inches is found to be required, by using two or more valves of equivalent area.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 53 vessels of 3,234 gross tons built in the United States and officially numbered during the month of January, 1903.

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THE VIBRATIONS OF STEAMSHIPS, WITH SPECIAL REFERENCE TO THOSE OF SECOND AND HIGHER PERIOD.—II.*

BY REAR ADMIRAL GEO. W. MELVILLE, ENGINEER-IN-CHIEF, U. S. NAVY.

Are the Unbalanced Forces of Higher Period in the Four-Crank Engine Important?

BALANCE OF DEUTSCHLAND

I shall answer this question by an examination of the unbalanced forces and moments of the *Deutschland* as she is, and as she would be if the cranks were at right angles. I thereby, incidentally, examine more fully than I did last year the claim of the Schlick engine to be called "balanced." In my last year's paper I showed that the *Deutschland* at ninety revolutions had an unbalanced second-period moment of 1,910 foot tons. The quotation just given from Mohr also shows, very impressively, the magnitude of this moment.

On the other hand, turning to Fig. 25 of Mr. Taylor's paper of last year, showing a complete scheme of the setting of the Schlick engine and the corresponding values, for each setting, of the second-period forces and moments, the result for what he pronounces the best settings is *apparently* most satisfactory. The unit he has used is stated in his Appendix C, and is the inertia of the whole reciprocating mass of the forward crank taken about the after crank. Now, this unit is enormous, and necessarily dwarfs anything that could be tolerated on board a full-powered ship.

The YST system was brought forward as an improvement on the ordinary four-crank engine, which is admitted by all to be very unbalanced. To what extent does this system effect an improvement? That, I think, is the fairest statement of the case.

Mr. Taylor's specification of the best conditions of setting of the YST engine, and the actual setting of the *Deutschland*, are as follows:

Mr. Taylor's specification, sections 27 and 28 of his paper:

Crank 4, reciprocating mass = 1
" 3, " " = about 1.5
" 2, " " = somewhere between 1 and 2
" 1, " " = about 1
" 4, crank angle zero
" 3, " " approximately 135° to 160°
" 2, " " in third puadrant somewhat less than 270°
" 1, " " approximately from 445° to 60°

Forward pair of cylinders to be as close as practicable, and after pair as close as practicable.

DEUTSCHLAND.

See p. 104 and Figs. A and D of my paper.

Crank I 22.2† = 1.
" II 32 ÷ 22.2 = 1.44
" III 32 ÷ 22.2 = 1.44
" IV 22.3 ÷ 22.2 = 1.00
" I crank angle zero
" II " " 158° 10′
" III " " 265° 10′
" IV " " 63° 20′

*Read at the meeting of the Society of Naval Architects and Marine Engineers, New York, November, 1902.

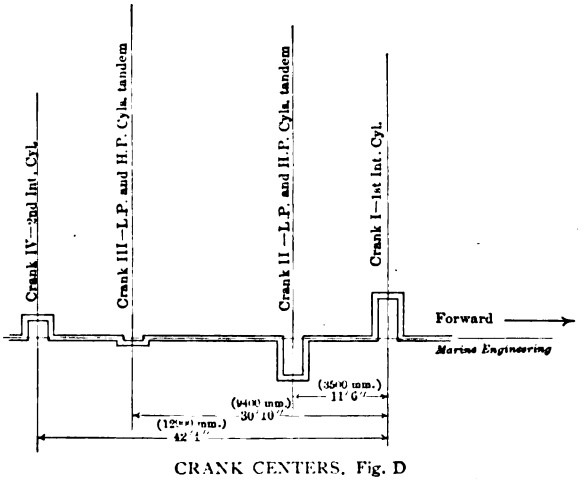
†From Fig. A cranks II and III have inertia = 268 tons for $m = 32$ tons. Therefore, for cranks I and IV we have $m = \frac{186 \times 32}{268} = 22.2$, and $m = \frac{186.6 \times 32}{268} = 22.3$ tons respectively.

Distance between cranks I and II, and between cranks III and IV = 11 feet 6 inches. Distance between cranks II and III = 19 feet 4 inches.

(Mr. Taylor's crank 4 and my crank I correspond, both being forward.)

Hence we see that, according to Mr. Taylor's specification, the setting of the *Deutschland* is almost ideal. For the sake of clearness, I reproduce Figs. A to D of my last year's paper, which give the examination for balance and unbalance of the *Deutschland* as made. Let us compare, then, the *Deutschland's* engine as it stands with what it would have been had cranks I and II been opposite, cranks III and IV opposite, but the first pair at right angles to the second pair, as in the usual arrangement.

First take the moving masses exactly as they are in the *Deutschland*. The result for first period is shown in Fig. 17. The forces and moments are the same as in Fig. A, and we obviously get the unbalanced force = $\{(268 - 186)^2 + (268 - 186.6)^2\}^{\frac{1}{2}} = 115.5$ tons; and the resultant unbalanced moment of 3,103 foot tons is similarly calculated; or, they may be at once measured from the diagram.



CRANK CENTERS. Fig. D

Fig. 18 gives the results for second period.

For fourth period, a diagram like Fig. C would show all the cranks in one plane, similarly directed. Hence the whole resultant is a vertical force passing through the center of the engine. This resultant is, obviously, from Fig. C, = .48 + .69 + .69 + .48 = 2.34 tons.

If, in Fig. C, the resultant had similarly been taken through the center of length of the engine, the value of the unbalanced moment would have been 8.8 tons. This is found by producing the line of the 1.71 unbalanced force through the center of the circle, laying off on this line a moment of 1.71 × 21 1-6 = 36.20 foot tons,—21 1-6 feet being the half length between cranks I and IV,—and combining it with the 37.2 foot tons. The new and old force systems are, of course, equivalent, but the smaller moment is given in the subjoined table to make the comparison fairer. If we treated the first-period moments in the same way, instead of 3,103, 2,848, and 1,736, in Table A, we would get 1,913, 2,090, 1,253 foot tons, respectively; values which would help greatly to strengthen my arguments. This would be a perfectly proper proceeding, as the engine is practically symmetrical about its center—but I feel that I can

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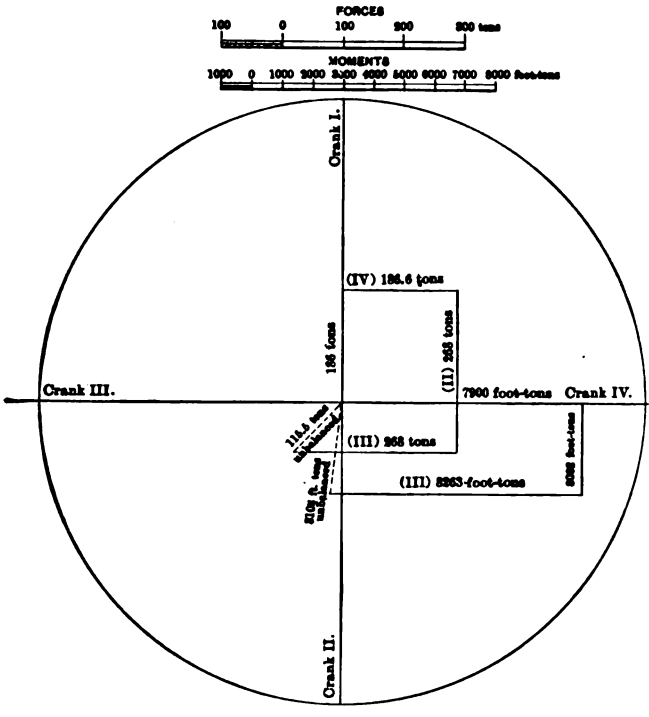
safely dispense with the help this would give. The large second-period unbalanced couples would scarcely be affected by a change in the point round which the moments are taken, as there is almost no unbalanced force.

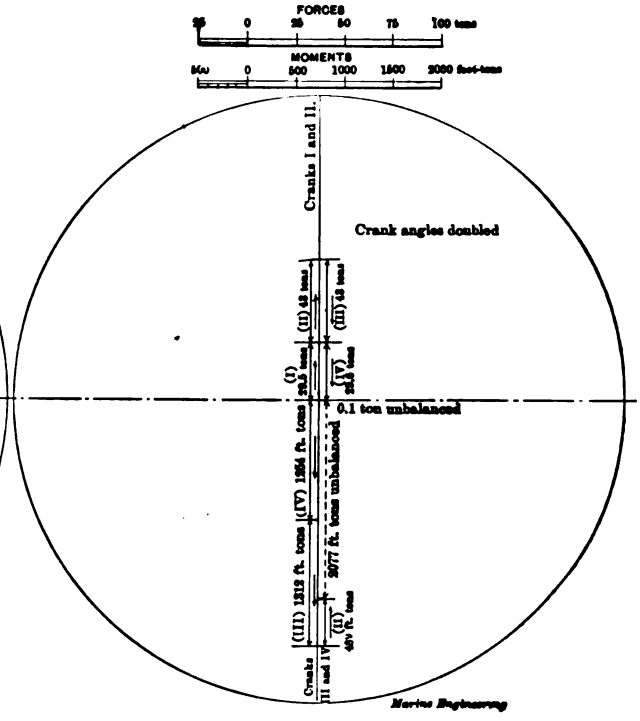
But considerable weight is added to the H.P., first I.P., and L.P. pistons to produce the YST balance. This we may deduct as follows:

	Weight as made	Reduction.	Reduced Weight.
Crank I	22.2	1	21.2 tons
Crank II	32	2 6	29.4 "
Crank III	32	2 6	29.4 "
Crank IV	22.3	0	22.3 "



1st PERIOD

Fig. 17



2nd PERIOD

Fig. 18

Calculating from these reduced masses, we get—

Unbalanced force of first period = 90.3 tons.

Unbalanced moment of first period = 2,848 foot tons.

But further, we may, by comparatively small revolving balance weights at the ends of the engine, or by counterbalancing the cranks, exactly balance all revolving weights. This leaves only the reciprocating masses to be dealt with. These I have taken in my paper as 5-8 of the total moving masses for each crank, and from this should be deducted the metal that may be saved off the pistons. We thus have—

Crank I	22.2 × 5-8 − 1	= 12.9 tons.
Crank II	32 × 5-8 − 2.6	= 17.4 "
Crank III	32 × 5-8 − 2.6	= 17.4 "
Crank IV	22.3 × 5 8	= 13.9 "

We can at once find the first-period forces and moments for each of these masses. Multiplication by .2540 and .0041 will give their forces and moments of second and fourth period, respectively, which are to be combined as in the foregoing diagrams. The resultants are given in Table A.

The last column shows what can readily be effected with the ordinary arrangement of cranks. Overbalancing the horizontal forces by slightly increasing the revolving counterbalances, which but infinitesimally increases the total machinery weight, would very considerably improve this result without producing sensible horizontal vibrations. By taking the resultant at the middle of the engine, the moment 1,736 would have been reduced to 1,253 foot tons and the comparison made fairer. But, taking the figures as they stand, we have a residual first-period force of 48.4 tons, or less than 1-5 of the force from crank II of the *Deutschland* as made. This would be considered a very small amount of unbalance. Even the 115.5 tons in the third last column is much less than half the force from crank II. We also see that the moment 1,736, which has been balanced by the Schlick system, is considerably less than the second-period moment of 1,976 which has been left practically unaffected.

But it may be objected that the third last column is the fair comparison. Accepting this position, I will show that the first-period moment of 3,103 foot tons (or more properly 1,913 foot tons about center of the engine) is much the less serious than the 2,077 foot tons of second period that the YST system fails to reduce materially; that is, under equally favorable conditions for producing vibration the second-period moment would produce *very much* the greater effect. All this will be evident whenever Table B has been studied.

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TABLE A.

UNBALANCED FORCES AND MOMENTS OF DEUTSCHLAND AS MADE, AND WITH CRANKS AS IN FIGURE 17. FORCES IN TONS, MOMENTS IN FOOT TONS, REVOLUTIONS 90 PER MINUTE, SUPPOSED.

Period.	Force or Moment.	As Made from Figs. A, B, and C.	Cranks as in Fig. 17.		
			Pistons as Made.	Pistons Reduced.	Piston Reduced and Revolving Weights Balanced.
1st	Force	0	115.5	90.3	48.4
	Moment	0	3103	2848	1736
2d	Force	1.7	0.1	2.1	2.1
	Moment	1910	2077	1976	1976
4th	Force	1.71	2.34	2.12	2.12
	Moment	8.8*	0	0	0

A glance at Table A should, at least, effectually dispose of the belief that second-period moments are negligible for the YST engine. The only way of justifying such belief would be by showing that the energy of second period is very quickly damped. I will give, in the last section, some of the results of an examination of this important subject. The question at the head of this section regarding the importance of higher-period forces in the four-crank engine must be answered with the most emphatic affirmative.

Are the Forces of Higher Period Sufficient to Account for Vibrations of Corresponding Period?

OUTLINE OF INVESTIGATION.

In Appendix I of my paper for *Engineering* I discuss, much more fully than would be convenient here, the question of the response of the ship to forces of various periods. I will only indicate briefly the line of reasoning and state the most important result.

I suppose only one period of vibration present at one time, as the problem becomes immensely complicated on any other supposition. Supposing the engine foundation immovable, take $F \cos n\theta$ as the expression for the inertia force of nth period, from equation (5) below, which the engine would apply as it revolved. But, as the ship is an elastic structure, the force of this period would cause a response at the point of application $= a \cos (\theta - \alpha)$. θ is the crank angle and α is the angular epoch of the response, the value of which varies as we approach or recede from perfect synchronism. For perfect synchronism, $\alpha = \frac{\pi}{2}$ which shows that the response lags one-quarter period behind the exciting force. If we follow this motion carefully, it at once becomes evident that energy will be communicated to the ship every vibration. It can readily be shown that the measure of this energy, per vibration, is $\pi F a$.

This supply of energy will cause a to increase, and this increase would go on until the ship is ruptured, were there not some cause of absorption of energy at work. It is analogous to the filling of a reservoir. However large the reservoir and however small the inflowing stream, it will be filled in time if there is no outlet. The rise of water level will only cease when the rates of inflow and outflow are equal. It is therefore essentially wrong to suppose, as has so often been done, that because F is very small for fourth and higher periods, it may be rejected. Before doing this it is necessary to examine carefully the whole question of the transfer of energy.

The absorption of energy in the vibrating ship is principally due to the action of the water. The resistance to motion may be taken as very approximately proportional to the square of the velocity. This law only I suppose here. I further suppose a nodal vibration, though Berling's observations seem to indicate that, for shorter vibrations than those with two nodes, the mode of vibration becomes very complex and cannot be compared to the nodal vibration of a thin rod. The particular supposition I make as to the number of nodes for the various periods, is:

Period	1	2	4	6
Number of nodes	2	3	4	5

This is to get definite numerical results; but the theory which I bring forward does not depend on a special set of suppositions.

The linear response will be greatest midway between the nodes, hence the unbalanced resultant *force* of the engine will produce its greatest effect if applied there. The greatest angular response will be at, or very near, a node, and the unbalanced *moment* of the engine will produce its greatest effect if applied at this point. For the sake of comparison of the various periods I suppose the forces applied midway between the nodes and the moments at the nodes, though this cannot be done with one and the same engine. As before, "force × frequency" is the measure of the importance of a vibration.

On the foregoing supposition the results in Table B can be demonstrated. In the second column are shown the forces which would produce vibrations of equal importance for the various periods. In the third column the same comparison is made for the moments. The two columns have no relation to one another. In the last column I give the coefficients for the various periods from the following equation for the inertia of a mass M moving with the crosshead:

Inertia form

$$= \frac{M\omega^2 R}{g} (\cos\theta + .2540 \cos 2\theta - .0041 \cos 4\theta + .00007 \cos 6\theta + \text{etc.}), \qquad (5)$$

where ω is the angular velocity of the crank in radians per second, supposed uniform; R, the crank radius in feet; g, the intensity of gravity; θ, the angle which the crank makes with its top stroke position, the engine being vertical inverted and having a connecting rod

*This figure is reduced from that of Figure C for reasons noted above.

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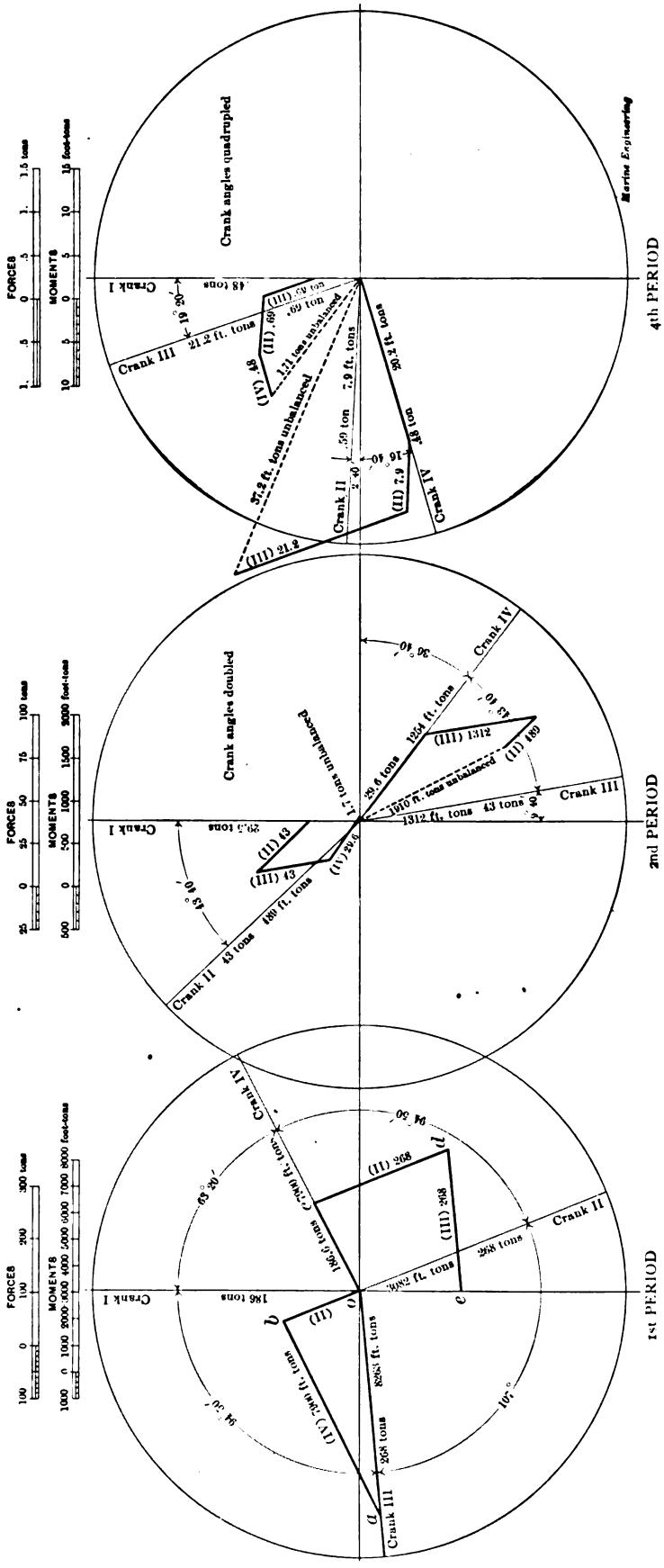


1st PERIOD Fig. A. 2nd PERIOD Fig. B. 4th PERIOD Fig. C.

four cranks in length. All terms but the first, in the foregoing series, on the right hand of equation (5) arise from the finite length of the connecting rod.

TABLE B.*

RATIO OF FORCES AND MOMENTS OF EQUAL IMPORTANCE.

Period.	Resistance Proportional to 2d Power of Velocity.		Coefficients of Equation (1).
	Forces.	Moments.	
1st	1	1	1
2d	.0625	.0415	.2540
4th	.0039	.0020	.0041
6th	.00077	.00031	.00007

* To make this table perfectly intelligible, I will show very simply that, under the suppositions made, the forces $F_1 = 1$ of 1st period, and $F_2 = .0625$ of 2d period, will give equally important vibrations.

If for 1st period a vibration having $a_1 = 1$ is produced by F_1, we must show that F_2 will produce a 2d-period vibration having $a_2 = 1{\cdot}8$. For the force produced on a body of mass m is $\frac{m n^2 \omega^2 a}{g}$, and force × frequency $= \frac{m n^2 \omega^2 a}{g}$, where n is the number of the period and ω the angular velocity of the engine crank shaft. Taking in turn the values,

1st period $n = 1$ $a_1 = 1$

2d period $n = 2$ $a_2 = 1{\cdot}8$

we get

1st period $\frac{m\omega^2}{g} \times 1^2 \times 1 = \frac{m\omega^2}{g}$

2d period $\frac{m\omega^2}{g} \times 2^2 \times 1{\cdot}8 = \frac{m\omega^2}{g}$

Thus the values of a_1 and a_2 supposed, belong to equally important 1st and 2d period vibrations.

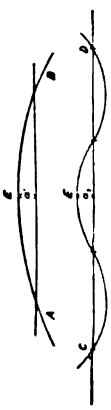
It remains to show that if for 1st period the rates of communication and absorption of energy are equal they will be equal for 2d period also.

Rate of communication of energy per vibration $= \pi F a$. Thus,

Per vibration, for 1st period $= \pi \times 1 \times 1$.

" " " 2d period $= \pi \times 1{\cdot}16 \times 1{\cdot}8 = \frac{\pi}{128}$.

In considering the rate of absorption of energy by the water we have the ship vibrating in different modes for 1st and 2d period.



TEACHING OF TABLE B.

The intensity of the forces and moments of the various periods which arise in any engine will, of course, depend on the arrangement of cranks and other points in the design. But we see how liable we are to get a response of second period if the circumstances are favorable. Hence, whether we take the smallest or largest value of the first-period moment in Table A, we at once see that, in the YST system, the moment balanced is of *far* less importance than the second-period moment which *cannot* be balanced.

Such are the figures deducible on the assumptions I have fully stated. To those who have not carefully studied the question, it will at first appear incredible that the moments of first and second period, which, under equal circumstances, are of equal importance, are in a proportion in any way approaching 24 to 1, as Table B shows. We cannot escape from the conclusion that the latter are of first-class importance by supposing a more favorable law of resistance. Even with a resistance varying according to the first power of the velocity—a law much more potent in damping out higher periods than we can possibly suppose—the ratio of first to second period moments of equal importance is 6 to 1. Even here, then, for equally favorable conditions, the second period would be far the more annoying.

Further, I maintain that my conclusions *are* borne out by the facts, and that the higher-period vibrations are *far* the more objectionable. This I am about to enforce. Table B indicates a similar conclusion as to fourth-period vibrations, and the frequent occurrence of these bears strong testimony to the truth of the whole deductions. For were the coefficients under the headings of Forces and Moments much too small, we would conclude that those of fourth period would never appear. Even sixth period, with a favorable arrangement of cranks, has a chance of putting in an appearance; and it no doubt composes part of the general tremors of the ship, which are so irritating, though these may be due to jars, or, as Macalpine and Flood pointed out in 1894,* to the resistance not following the simple harmonic law.

CONCLUSIONS SUPPORTED BY PALLOGRAMS FROM KAISERIN AUGUSTA.

The pallograms from the *Kaiserin Augusta* bear strong evidence to the truth of Table B. Fig. 10 shows the largest first-period vibration for this ship given by Berling.

Probably here we have nearly perfect synchronism, as no doubt he was investigating both the worst and best conditions. Similarly Fig. 11 gives, with probably one exception, the worst second-period vibration, and we may again suppose synchronism.

TABLE C.

COMPARISON OF IMPORTANCE OF 1ST AND 2D PERIOD VIBRATIONS AND INTENSITY OF FORCES AND MOMENTS FOR KAISERIN AUGUSTA.

Figure.	Number of Engines Working.	Revolutions.	V.	Relative Maximum Value of Moments and Forces.	
				Revolving Parts Balanced.	Revolving Parts Unbalanced.
10	3	102	.67	1.	–
11	2	105	1.05	$\frac{1\times.2540\times105^2\times2}{102^2\times3}=.179$	$.179\times\frac{5}{8}=.112$

The connecting rod I have taken as four cranks in length, which seems to be indicated by a very small scale drawing in the translation of von Jaski's paper.† In this form of engine, supposing only the reciprocating masses unbalanced, the unbalanced forces and moments of first and second period are, as is well known, in the proportion of the first- and second-period forces, equation (5). Hence the factor .2540. If the revolving parts are unbalanced, and the reciprocating parts form 5-8 of the whole moving masses, we must multiply the .179 in the second last column by 5-8 to get the correct relative values of first- and second-period moments. The factors $105^2 \times 2$ and $102^2 \times 3$ correct for the revolution and number of engines at work.

Here we have, then, a relatively very small force and moment of second period producing a second-period vibration over 50 per cent. more important than that of first period.

In judging the figures in Table C it should clearly be borne in mind that, with resistance varying as the square of the velocity, the second-period forces or moments required to give $V=1.05$ are much larger than those which would have been required to give $V=.67$ for this period; they are, in fact, larger in about the proportion $1.05^2/.67^2=2.46$. Thus the support which is given by the pallograms of the *Kaiserin Augusta* to the truth of Table C is very striking.

There being first- and second-period vibrations present

Suppose for first period it vibrates in any mode, say as at *AEB*, and for 2d period as in any other mode *CED*. The resistance is supposed proportional to the square of the velocity, and therefore varies from point to point of the ship.

But the flexure between any contiguous pair of nodes produces practically a similar curve whatever the number of nodes. (This no doubt holds more closely for a thin rod than for a ship, and the flexure outside the outer nodes is not similar to that of the parts between; both of which slightly modify what immediately follows.) Hence whatever the number of nodes, for comparative purposes we may use the velocity as *E*, midway between two nodes, when estimating resistance, and thus avoid a difficult integration over the whole surface of the ship or rod.

The engine is supposed placed at the point *E* always between two nodes, when considering forces, as there they have the greatest effect.

The resistance is $C \times n^2\,\omega^2 a^2$, and the energy absorbed per vibration $K \times n^2\omega^2 a^2$, where *C* and *K* are approximately constants. Thus, energy absorbed

$$\text{Per vibration for 1st period} = K\omega^2 \times 1^2 \times 1^2 = K\omega^2.$$

$$\text{" " " 2d " } = K\omega^2 \times 2^2 \times \frac{1}{8^2} = \frac{K\omega^2}{128}.$$

Hence, if the rates of communication and absorption of energy are equal for 1st period, they are equal for 2d, so that $F_1 = 1$ and $F_2 = 1\text{-}16$ give equally important vibrations under the conditions supposed.

*See *Engineering*, vol. lviii., p. 83.

†Results of Investigations of Recent Engines of the German Navy, by Chief Constructor Kohn von Jaski. *Schiffbau*, June 8, 1900, p. 507. Translation, *Journal American Society Naval Engineers*, vol. xiv., p. 18.

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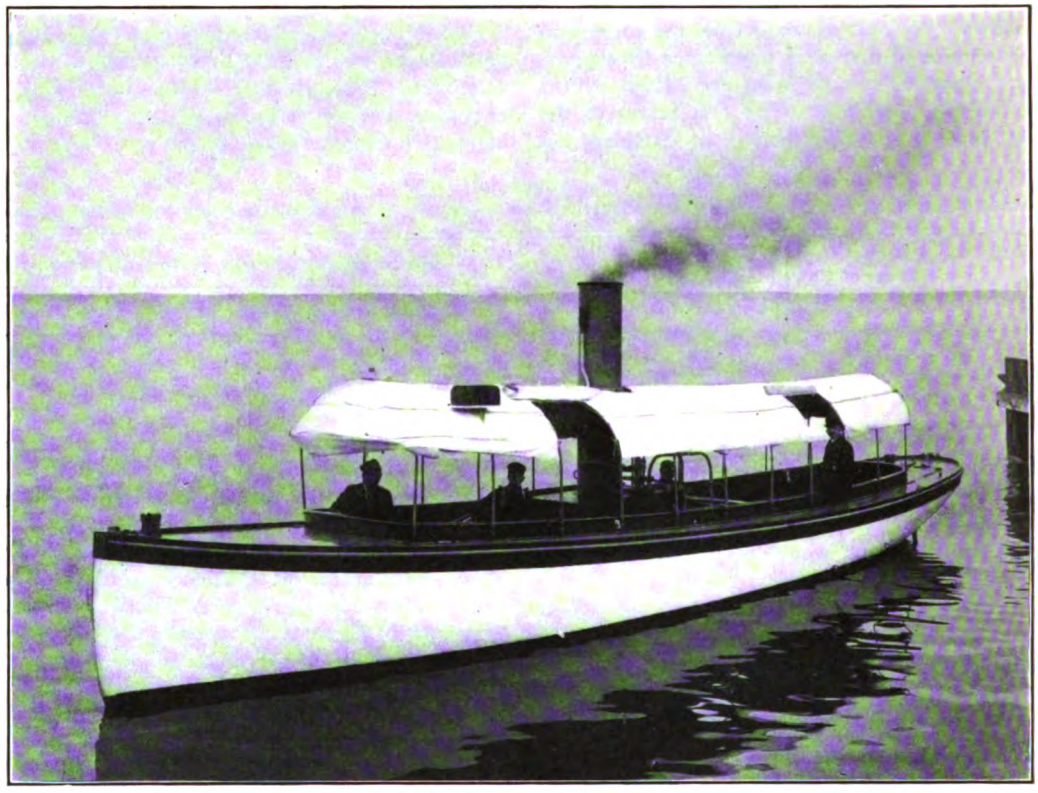
would be sure, in this case, to produce a powerful damping effect on the latter, so that the case is even stronger than appears from the figures. More exact comparison would be unprofitable, as the data are somewhat doubtful; we do not know that synchronism was exact or that the relative positions among the nodes for first and second period were equally favorable. Besides, the vibrations are not measured at the same part of the ship. But it practically assures us that the rate of absorption of energy varies with a power of the velocity much over the first, and probably as high as the second.

Theory, then, leads to the conclusion that the higher-period unbalanced forces of the engine are able to produce the vibrations of corresponding period found by experiment.

STEAM LAUNCHES FOR THE WAR DEPARTMENT.

Two 45-foot steam launches were recently finished by the Electric Launch Company, Bayonne, N. J., for the War Department of the United States Government. One of the launches, named the *Lancaster*, was shipped to New Orleans and the other one is for use at New London, Conn. The vessels were built from the same specifications, which called for very heavy construction throughout. They are much the same as the Navy Department launches. The successful bidders have for many years been building electric and gas-engine launches, sailing yachts, and other small craft. The boats here described were built within seventy-five days of the date of contract.



STEAM LAUNCH LANCASTER, BUILT FOR THE U. S. WAR DEPARTMENT.

TORSIONAL VIBRATION OF SHAFTING.

The question of torsional vibration of the shafting has come much to the front in the last few years. It is a subject of the deepest interest and importance. I will not enter on it in this paper further than a few words. In only a limited number of cases can exact balance of the impulses causing torsional vibration be effected; hence its presence in some degree we must be prepared for. If it is not to produce a greatly aggravated transverse vibration of the ship, we must adopt a balanced engine. But as torsional vibration is almost always of second, third, or fourth period, any engine balanced only for first period cannot, in this case, be considered to be balanced at all.

I believe that it will be admitted that I have now supplied overwhelming evidence of the correctness of the position I took up last year.

HULL CONSTRUCTION.

Keels of clear tough oak, 4 by 6 inches, with a 6 by 2-inch covering piece and a 4 by 1-inch oak shoe or false keel. The frames are of clear white oak, steam bent, 1 1-2 inches sided by 2 inches molded at heads and 3 inches at heels. The keelson is laid on the frames above the keel and is of 3 by 6-inch yellow pine. The stem and stern post of oak of size and shape as shown. The floors are of oak, 1 3-4 by 3 inches at throat. The side keelsons are yellow pine, 3 1-3 inches, and the bilge stringers, 2 1-2 by 5 inches, made of the same material and tapered at the ends. The clamps are tapered, of yellow pine, 2 by 6 inches. Three breast hooks of oak, natural knees, 3 1-2 inches thick. Knees were shown of oak or hackmatack. Sheer strake of oak, 1 1-2 by 7 inches, tapered. Outside planking of clear white cedar, 1 inch thick and not over 7 1-2 inches wide amidships. Fender 1 1-2 by 3

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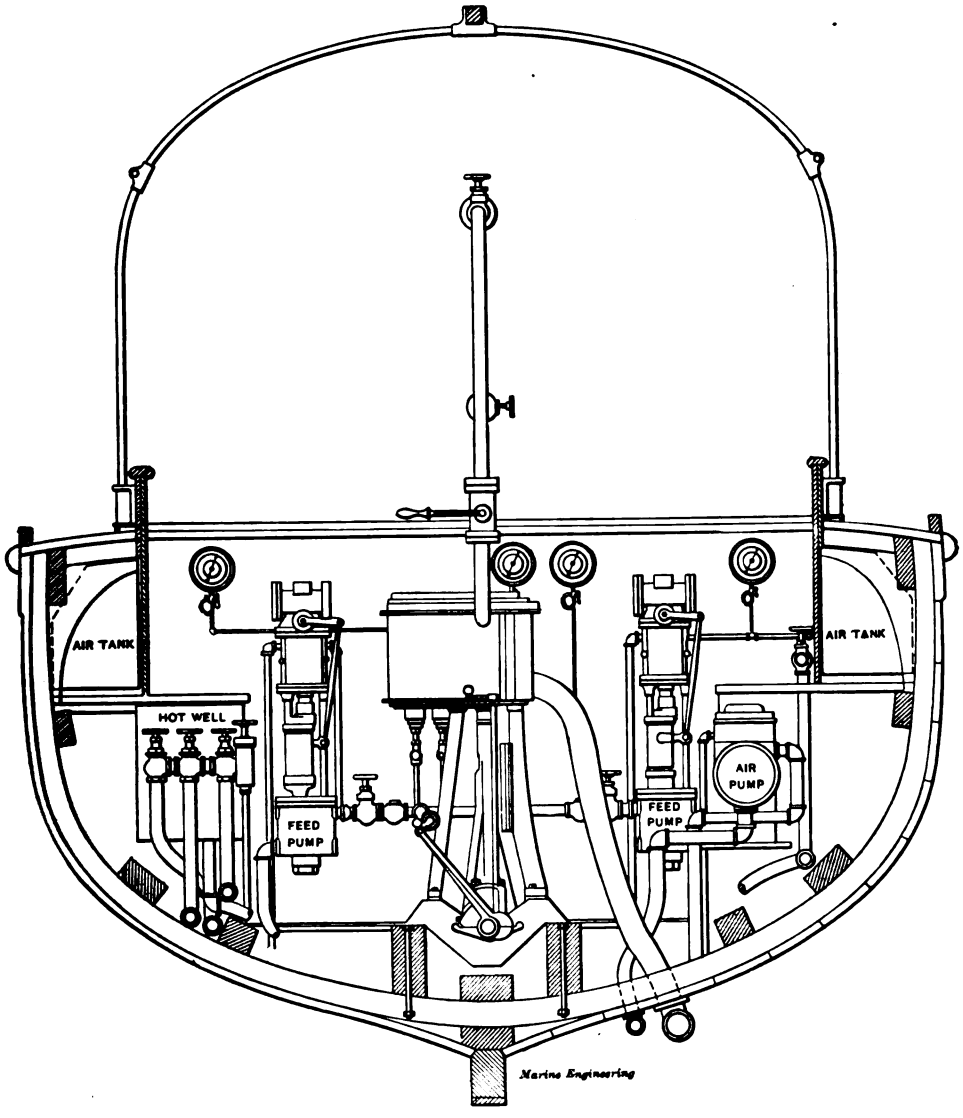
inches, of oak and tapered fore and aft. Rail of oak, 1 1-2 by 2 inches. Planksheer of oak, 4 1-2 by 1 inch, tapered at ends. Deck of clear white pine, 1 3-4 inches width by 1 inch thick. Coamings around cockpits to be of oak, 1-2 inch thick by 6 inches high, with a cap of cherry or mahogany 2 5-8 by 1 1-2 inches. Deck beams and floor beams of oak, 1 1-2 by 2 inches, dovetailed into clamp and stringers. Deck stringer of oak, 2 by 2 inches. Staving of cockpits to be of 5-8 by 3-inch tongue and groove mahogany. Cockpit floors to be of 3 by 3-4-inch white pine tongue and groove ash gratings where shown. Filling pieces of white pine, 6 by 3 inches. Ceiling of sides of hull in coal bunkers of 1-2-inch tongue and groove yellow pine, top of coal bunkers of 7-8-inch ash. Engine keelson of yellow pine, about 4 by 12 inches, as may be required, cut down over the floors 1-2 inch. Stern seats to be of ash with coaming around edges for cushions, with lockers underneath. Forward seats to be of ash with lockers underneath; all materials to be of suitable dimensions.

Keel, keelson, stringers, clamps, covering piece, and shoe to be in one piece for their entire length, as shown.

Fastenings.—Heavy copper fastenings and rivets shall be used for planking and frame. All screws of joiner work shall be of brass. All exposed nail or screw heads to be countersunk and flush plugged.

Calking.—Seams of planking and decks to be calked with spun cotton and payed with paint and filled with white lead putty.



MIDSHIP SECTION OF WAR DEPARTMENT STEAM LAUNCHES.

Painting.—Planking and frame to have three coats of best white lead outside and inside, except floors and inside of hull in machinery space, which is to be finished with three coats of lead color paint. Lettering on bow.

Coppering.—Launch to be coppered over with felt with 14-ounce metal nailed with 5-8-inch nails; copper to extend from a line 6 inches above load-water line forward and 3 inches aft on sides around keel for the full length of the boat. The keel shoe to be put on outside of the copper, in order to protect it from being torn should the boat ground.

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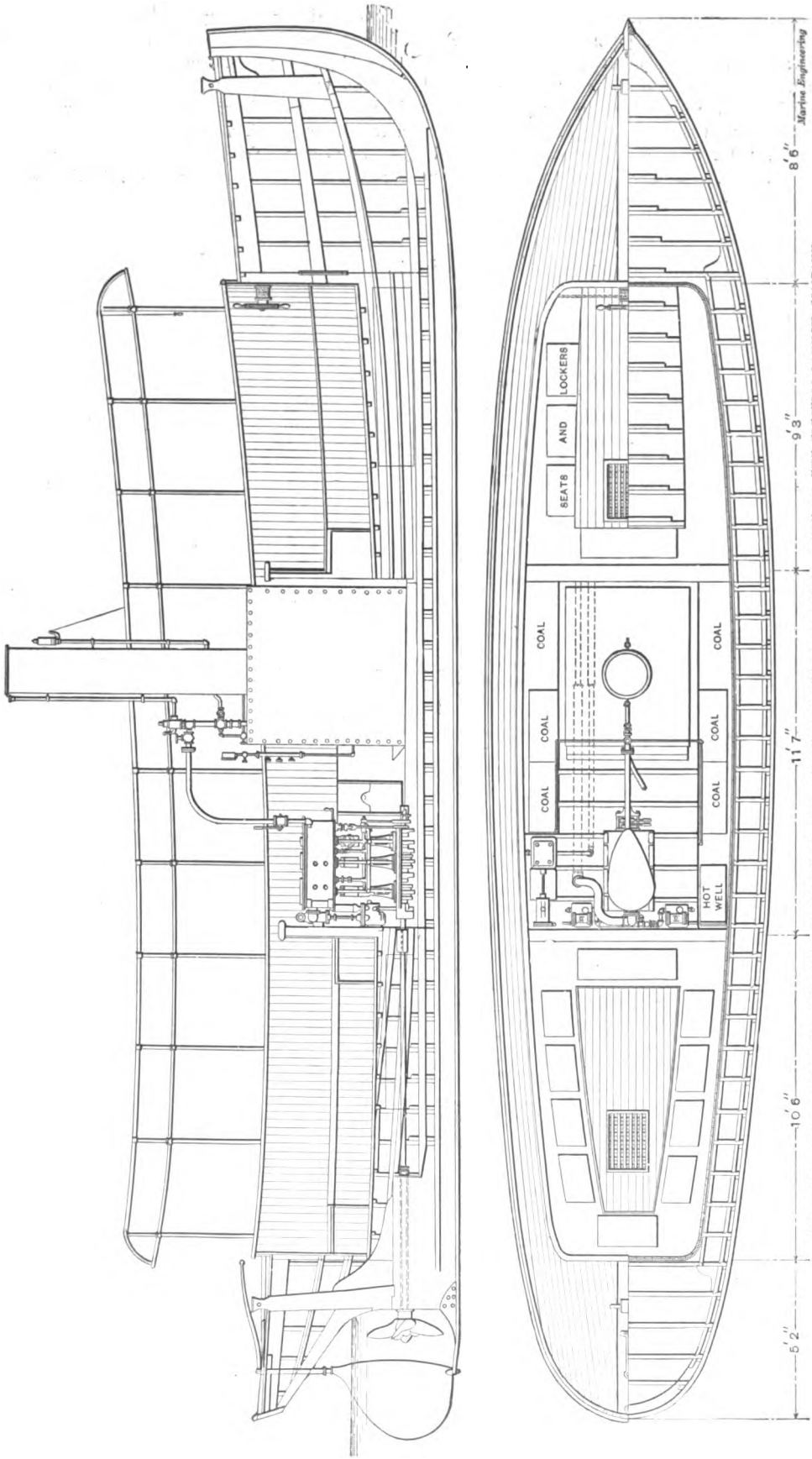

DECK PLAN AND LONGITUDINAL ELEVATION OF THE U. S. WAR DEPARTMENT STEAM LAUNCHES, BUILT BY THE ELECTRIC LAUNCH COMPANY.

Varnishing.—Fender, planksheer, decks, and interior to have three coats of best spar varnish, after being properly filled with an approved filler and rubbed down.

Towing Bitts.—Stern post to extend through the deck, as shown, and to have a strong composition pin through same. A riding bitt with composition pin to be strongly framed into fore part of launch.

Rudder, Scag, etc.—The rudder and scag, propeller wheel, stern bearing, rudder post, stuffing box, cutwater or steam band, and all other outboard fittings to be of bronze and of approved design.

Bulkheads.—Water-tight bulkheads, of 1-8-inch galvanized steel, to be placed forward and aft of cockpit, an air chamber being arranged on each end. Manhole to forward chambers. Copper air tank about 3 feet long, of No. 18 gage, and as large as is possible, properly stiffened, to extend along the entire side under deck, as shown. Steel bulkheads athwartships, one forward of boiler and one aft of engine, the latter to have opening with cover, where necessary, to allow of getting at low-pressure valve gear and valves as may be re-

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quired. Cover to be hinged and bolted in place; joints to be water-tight.

Coal Bunkers.—To be constructed of 1-8-inch galvanized steel and angles alongside of boilers, substantially as shown. Provide openings in top for filling and steel sliding chute on side to fire room.

Lockers.—To be arranged under the seats of forward and after cockpits and at the side of the engine room, all as shown. All fittings of polished brass.

MACHINERY.

Engines.—The engine is of the "Sullivan" make, of the fore-and-aft triple-expansion type, capable of working under a steam pressure of 250 pounds without undue strain, supported on steel stanchions well braced and secured, and thrust bearing attached. All bearing surfaces are extra large, well provided with oiling attachments, and have an arrangement for taking up the lost motion. A central sight feed oiling reservoir is connected to all bearings and pins by small brass tubes. The crank shafts are of high-grade forged steel, with cranks set at 120 degrees; propeller shaft is of Tobin bronze, and the crankpin and other main bearings to run in white metal boxes. All bolts and nuts are finished and case-hardened, with checks on the main bearings and moving parts. The necessary relief valves and drain cocks are attached and piped up as required.

NAME—Lancaster. NATIONALITY—American. TYPE—Steam launch.
BUILDER—Electric Launch Company. LAUNCHED—1902. OWNER—U. S. War Department.

Length over all	45 ft.	Valves	all piston
Beam	9 "	Steam pressure	225 lbs.
Depth	5 "	Revolutions per minute	495
Displacement, load	24,500 pounds	Boiler	one water-tube
Corresponding draft, bow	2 ft. 6 ins.	Size	floor space, 4 by 5 ft.
" " stern	3 " 6 "	H. S.	321.5 sq. ft.
Engines, type	triple	G. S.	12.68 " "
Cylinder diam.	4, 7, and 11 ins.	Propeller	4 blades, bronze casting
Stroke	7 1-2 ins.	Diameter	28 ins.

Boiler.—Steam is generated by a water-tube boiler, of latest and approved design, of sufficient capacity to drive the above engine at least 500 R.P.M. without excessive forcing and to supply all the steam required, the boiler being built in accordance with the laws of the United States Treasury Department, for a working pressure of 250 pounds, and proven tight under a hydrostatic pressure of 500 pounds per square inch. The ashpan is of galvanized steel; wrought-iron shaking grates; ashpan doors and fire door, as well as entire casing, to be of the best for their purpose and of approved materials and thickness. Handholes, steam hose and connections are fitted for blowing soot and ashes from water heaters and base of tubes or manifolds. The safety valve is set at 175 pounds. The boiler and heating coils are of standard 1-inch steam pipe. The boiler is fitted with all necessary gages and cocks. The gases from the fire are led into a double smokestack of No. 18 iron.

Pumps.—The air pump is of the Marsh type, 4 by 4 by 6 inches. The boiler is fed with two Davidson single-cylinder feed pumps, 4 by 4 1-2 by 4 inches. A hand pump and ejector are connected with the bilge.

Piping.—All the piping is of brass or copper. The main steam exhaust and feed pipes fitted with flanges brazed on according to navy practice. All the fittings are of the heavy pattern of the smaller types and have unions brazed on. The valves are of extra heavy composition.

Condenser,—An outward type condenser, capable of condensing the steam from the engine and maintaining a good vacuum, is of copper, the whole secured to the throat of the hull and protected by cutwater blocks.

Water Tanks.—There are three water tanks, made of No. 18 copper, well stiffened and secured and provided with filling pipes, suctions, strainers, water-tight handholes. One of these tanks is placed under the floor of the after cockpit, with a shaft casing running through the same, one under the floor of the forward cockpit and one in the air chamber at the bow, with a combined capacity of 250 gallons, and all leading to manifold in the engine room.

Miscellaneous.—The steering gear to consist of a 24-inch brass steering wheel forward and a hand tiller aft, connected up with brass wire rope and chains, as shown in the photograph. The awning is carried on a galvanized frame set in composition sockets and is of No. 5 canvas. The other parts of the outfit include screenboards for the side lights and bow lights, chocks, cleats, two flagpoles, three boathooks, one pair of ash oars, a set of brass sailing lights and engine-room lanterns, bells for engine room, a complete set of wrenches, oil cans and firing tools, a 75-pound galvanized folding anchor with 120 feet of manila 3-inch rope, fenders, and spare parts of the engine will include one set of grate bars, feed heating coils, two links and valve rods, a set of crankpin frames, a set of wristpin blocks, and one link block.

It is evident from the above specifications that these launches are especially heavily built and of the very best material throughout. The hull alone weighs about 9,000 pounds, and the copper fastenings, including air tanks, weigh from 1,300 to 1,500 pounds. The cost of

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building under these specifications is about 10 per cent. above what it would be under the usual form of specifications.

The rigidity of these vessels was shown on their trial trips, which were run in smooth water on Newark bay. With the engines running at 500 revolutions there was no vibration perceptible. Steam was raised from cold water to 150 pounds pressure in about 25 minutes; on another day, with a wood fire, the steam pressure was raised in 12 minutes and the safety valve was set to blow off at 225 pounds. The steam jet was kept on slightly in order to maintain the pressure when running at full speed. One of the feed pumps sufficed to keep the boiler well filled with water, and the Marsh air pump gave a good vacuum when making 70 strokes per minute. The following data were obtained:

Steam pressure, pounds.....	175	225	250
1st receiver pressure, pounds...		80	
2d receiver pressure, pounds....		13	
Vacuum, inches.....		26	
Revolutions per minute.....	440	495	525
Mean speed, miles.....		10 9-10	

A full turn of the boat was made in about two lengths.

GAS ENGINES AND THEIR TROUBLES.—IX.

BY E. W. ROBERTS.

Making Repairs.

Quite often the occasion arises when the operator of a gas engine finds it necessary to make a repair when quite a distance from a machine shop. There are tricks in every trade, and the little trick of knowing what to do in an emergency of this kind is quite convenient. For instance, it would be apparently disastrous if the operator of the single-cylinder engine should find that his cylinder head packing had blown out and had no sheet asbestos on board. Again, sheet asbestos of the proper kind for packing a gas-engine cylinder head is not always readily obtainable, and hence the knowledge of a satisfactory substitute would be of great assistance under such circumstances. Sheet copper embedded in white lead is not only a good substitute for asbestos packing, but a great many people think it an improvement. Both the gasket and the joint should be well coated with white lead and the cylinder head drawn firmly into place by the nuts on the cylinder-head stud, taking another turn after the engine is warmed up. Sheet lead is another very good substitute for asbestos, and, in fact, has proven a satisfactory gasket in places where the asbestos packing would not hold. Even well-oiled manila paper will make a temporary repair, and for packing in places not exposed to high temperatures, especially for the cover of a rotary pump, oiled paper is about as good as anything else. It should be put on, however, in from four to six thicknesses and tightly compressed.

REGRINDING A VALVE.

For regrinding the exhaust or the inlet valve of a four-cycle engine the grit that is given off from a grindstone is by many considered much better than emery. Finely powdered and sifted glass, especially of the flint-glass variety, will also answer for this purpose, or even a little of the grit from a piece of fine glass paper, commonly known as "sandpaper," will also do the work. This glass paper grit, if not too coarse, is a very good material, as it is usually a good quality of flint glass. Valves should be ground with a continuous rotary movement and a slight pressure, always using the grit mixed with oil.

It often happens that when putting too great a strain on a nut the thread on either the bolt or in the nut is stripped and will not take hold. This quite often happens when the nut was originally a poor fit and there is little thread remaining. Sometimes you can make the nut hold temporarily by winding the bolt with a piece of string. If the nut be a small one it can be struck with a hammer on the flat, so as to make the hole elliptical, and this will make it fit temporarily, if the strain is not too great. This is not a very mechanical method, but it will sometimes answer in an emergency.

Leaks in the gasoline system may be temporarily mended with common brown soap, and a leak in the gasoline pipe may have a temporary repair by wrapping it with tape or with strips of cloth well covered with the same substance. Shellac, which is not soluble in gasoline, may be used in place of soap in conjunction with the tape. It should be put on while wrapping the tape around the pipe, as it dries very quickly, and afterward a good coating of shellac should be put over the entire joint. Both of these methods should be used for temporary repairs only and a permanent repair made with solder at the first opportunity.

In launches equipped with an air-pressure system for starting it is often quite difficult, when the outfit is new, to hold the air pressure for any length of time, but after the machinery has been exposed to the moisture of the air the joints will often rust tight. However, a very good way to insure a tight job at the outset is to take down this air system piping, tin all the threads, and screw them together again while hot with a little melted solder on each joint. It is not a bad plan to insist that the manufacturer use this method of construction when putting up the job, and thus save yourself the trouble.

ELECTRIC EQUIPMENT.

It sometimes happens that the battery will give out when in a locality where it is impossible to secure supplies for its renewal or new cells of a similar type. Frequently, however, it is possible to obtain dry cells such as are used for electric bells, and these will often answer for a short time, especially if two batteries of about five cells each be set up so that the current may be switched from one to the other at intervals of half an hour. These batteries will probably answer for several days or until new ones of the regular type can be obtained. If a bell battery of the wet type be the only sort obtainable, the cells should be fitted with wooden covers to prevent the electrolyte from splashing over. The small storage batteries used to operate a phonograph will do very well in an emergency.

The platinum tips or contact points on the igniter electrodes sometimes get loose and are difficult to secure when far from a city. In an emergency brass or silver will answer, but are not, of course, so good as platinum. It might as well be noted here that there are several alloys fully as good for this purpose as platinum, and at the same time considerably cheaper. In the absence of facilities for brazing, the points may be put entirely through the electrode and riveted.

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Turning off the cylinder oil for a few minutes before the engine is stopped will, with many engines, allow the surplus oil to be burned away from off the cylinder walls and prevent a gummy deposit in the packing-ring grooves. Turning off the igniter switch before closing the throttle and stopping the engine will usually leave a charge in the cylinder at the last stroke of the piston, and make the engine easy to start next time you are ready to go. Never forget to turn off the igniter switch when stopping the engine, as it will save your battery and a possible short-circuit. In order to determine whether the spark coil is working properly, the simplest way is to hold a light piece of steel or iron near the end of the core so that it will swing. Then each time the circuit is closed and broken the piece of iron will swing toward the coil and be immediately released when the circuit is broken. This is a very simple method of finding just when ignition takes place in the cylinder.

In some makes of engines flat springs are employed on the igniter and they are very likely to break at the most inopportune moments. They can usually be replaced by a portion of an old clock spring, which, if not stiff enough in a single thickness, may be strengthened by using two thicknesses or more. If it is necessary to drill the spring it may be accomplished effectually by keeping the point of the drill sharp and using turpentine as a lubricant. A brass spring will also answer for a short time, and soft brass may be "tempered" by hammering it. This will, of course, thin the brass and necessitates the use of a sheet somewhat thicker than required for the spring. Generally a brass spring should be about twice as thick as a steel for the same purpose. German silver wire is quite often used for valve springs instead of steel, especially in locations where the spring is apt to get hot and steel would lose its temper. In case the valves hammer badly on their seats and make a disagreeable noise, the trouble may be overcome by the use of a light buffer spring or a piece of soft rubber or even leather.

RUNNING WITH ONE CYLINDER.

In case one of the cylinders on a multiple-cylinder engine should become inoperative while on a trip, the compression in the cylinder should be relieved, if possible, as this will allow the other engines to run at a higher speed. In the case of a damaged piston or connecting rod the rod should be disconnected from the crank pin and the piston blocked up or removed from the cylinder. In the case of a two-cycle engine, relieving the compression would not prevent the suction of air from the vaporizer, and in case a common vaporizer is used, so that the gasoline cannot be cut off from the cylinder, the passage from the crank case should be blocked in order to save gasoline and the driving of the explosive mixture into the muffler.

WATER-JACKET PUMP.

If the water pump stops working the trouble may be caused by clogging of the screen at the opening into the sea, or a small particle of dirt under one of the check valves, or too strong a spring on a spring check. The writer has cured a pump of failure to operate by removing the spring from the top of the suction check, the weight of the valve itself being found sufficient to bring it back to its seat. On high-speed engines with the piston pump operated directly from the crank shaft, it will often be found that the water will not follow the piston and the pump will simply draw a vacuum and no water. This is a trouble that I have seen cured by placing a flexible rubber bag just outside the suction check, either on the leg of a tee or so as to form part of the suction pipe. This insures a supply of water close to the pump, which will flow in at quite high speeds.

It should also be noted that a high-speed pump should be located, if possible, below the water line and that the suction pipe should be of ample proportions. Increasing the size of the suction pipe is sometimes an effective remedy for a badly-acting pump. A rotary gear pump is really to be preferred to one of the piston variety for all speeds, as the absence of check valves and the immunity from troubles caused by small particles of dirt are decided advantages. These pumps work best when the water flows to the suction, although when new they will generally draw quite a little distance.

In a two-cycle engine it is very important that the crank case be kept tight, for a leaky crank case will cause a considerable falling off in the power of the engine. Occasionally, although not very often, a leak in the wall of the crank case will develop from the jarring out of a particle of sand. These holes may be stopped effectually by means of a paste made as follows: Mix litharge, red lead, and glycerine in equal proportions so as to make the mixture about the consistence of putty. Apply this in the same manner as putty is used in filling wood. This paste should then be allowed to harden and it will be found almost as sound as the iron itself.

In all cases of accident at sea do not get confused, above all things, for quick wit in emergency will get one out of a very tight place in the majority of cases. It is often the brag of a good gas-engine runner that he has never been towed home, but got back under his own power, even if it took him all night to make the necessary repairs.

(The End.)

Steamship Cedric.—The new White Star Line steamship *Cedric*, which is practically the same as the *Celtic*, arrived in New York on her maiden voyage on February 21. The general dimensions of this ship are: Length over all, 700 feet; breadth, extreme, 75 feet; depth, 49 feet 4 inches. A description of the ship will be given to readers of MARINE ENGINEERING in the April number.

New Canadian Shipyard.—It is reported that the Canadian Pacific Railway will build several large freight steamers for service on the Great Lakes, and, with this end in view, the road will, it is reported, give financial backing to the extent of $1,000,000 to the Bertrams, of Toronto, for building and equipping a plant where ships may be completely equipped. The site for the plant is stated to be Sandwich, Ontario, opposite Detroit, Mich.

Lumber Raft.—On the Pacific Coast great quantities of lumber are brought down the rivers and made up into gigantic and immense rafts and then towed down the coast to San Francisco or other ports where lumber is to be delivered. One raft, containing 8,000,000 feet of piling, recently built by the Robertson Raft Company, was towed from the Columbia river to the Golden Gate by two sea-going tugs in eight days.

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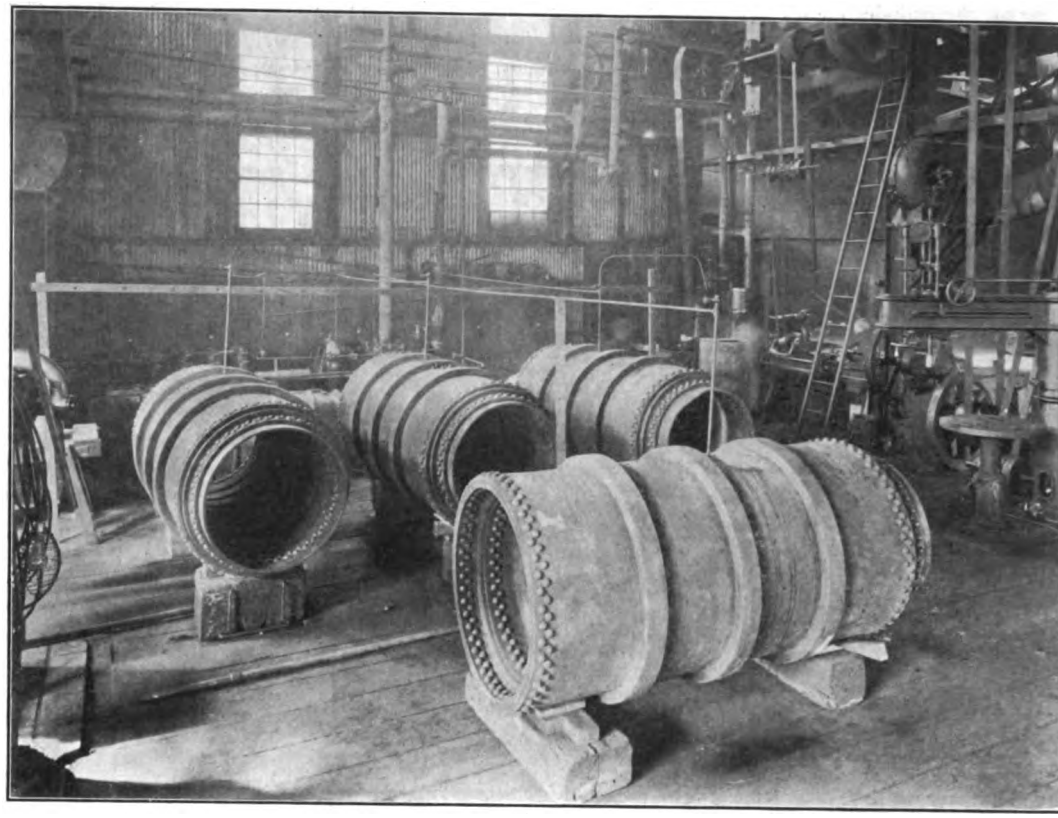

BROWN FURNACES MOUNTED FOR TESTING IN THE MACHINE SHOP OF THE CRAMP DRY-DOCK COMPANY.

TESTS OF CORRUGATED FURNACES.

A most interesting series of tests was made at the works of the Cramp Dry-Dock Company, Philadelphia, Pa., on February 3, 1903, of the Brown patent improved corrugated furnace. The tests were held under the direction of the Board of Supervising Inspectors of Steam Vessels and were witnessed by a representative gathering of about a hundred engineers from the shipyards and boiler works throughout the country. The furnace is the latest design of John Brown and Company, Sheffield, whose furnaces have for many years been in general use on the other side of the Atlantic in cylindrical boilers, both on land and sea; the selling agents in this country are Worth, Baily and Company, Philadelphia, Pa.

The Brown furnace differs from other furnaces on the market in, first, its method of manufacture, and, second, its design. The plate selected is of greater thickness than that of the finished furnace. It is then heated and passed through the corrugating rolls. Here the corrugations are left of heavier metal than the rest of the plate, for, when the furnace is in place, under pressure in the boiler these corrugations, being at the greatest diameter, are subjected to the greatest stress. The corrugations are spaced nine inches center to center, and the space between them is left flat. This surface is left flat because it is found to transmit more heat than a corrugated surface, and also because it is an easier furnace to fire.

The plate is sheared cold, and the welding edges bevel sheared. It is then wrapped into the form of a cylinder, the edges to be welded brought to a welding heat and welded by special hammers. The weld thus being made after rolling the corrugations, it is not subjected to the strains incident to passing through the rolls. The furnace is then placed vertically in an annealing furnace, and, when at the proper heat, is brought to a special hydraulic press which takes out the flat produced by the welding operation. It is then pickled and dressed, shaped, flanged, cut to size, adjusted to iron templates, and once more annealed. As it has been rolled from a thicker plate, the ends may be left heavier for riveting to front or back connections.

The steel used is of medium tensile strength of about 60,000 pounds, as experience has shown that plates in contact with flame should be of comparative low tensile strength and correspondingly greater ductility.

The furnaces tested were four in number, and mounted as shown on drawing, page 145, and in the engraving above. Each was securely riveted within a heavy cylinder braced by 4 by 2-inch bands. The space between cylinder and furnace was connected up to a pressure pump and accumulator, as will be seen in the engraving, by one-quarter-inch piping, and a hydrostatic pressure applied till the furnace collapsed. Horizontal and vertical diametrical measurements were taken by gage on the first, fourth, and seventh flats, first before the pressure was applied, and then at increasing pressures up to 700 to 800 pounds per square inch. The pressure was at that point released and the dimensions taken to see if there had been any permanent set. After this the pressure was applied until rupture occurred.

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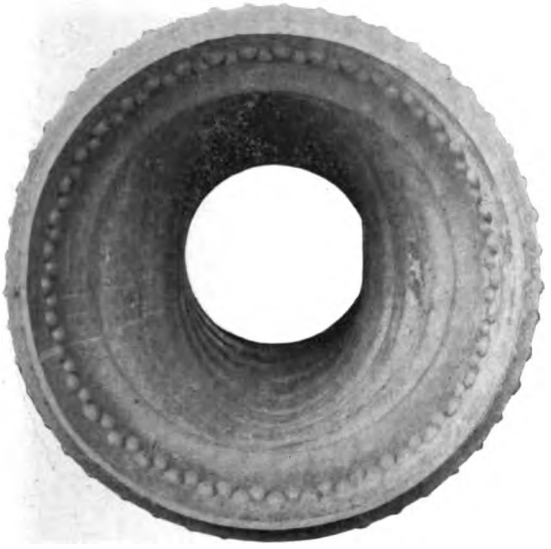

FURNACE NO. 103 AFTER DESTRUCTIVE TEST.

FURNACE NO. 104 AFTER DESTRUCTIVE TEST.

1st. 4th. 7th Flats.

Pressure in lbs. per Square Inch	Front.		Middle.		Back.		Remarks.
	Vert.	Hor.	Vert.	Hor.	Vert.	Hor.	
Original Diameter.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	
0	29 5/32	29 4/32	28 31/32	28 31/32	28 28/32	28 28/32	An entire collapse end to end at top and bottom.
400	29 9/64	29 7/64	" f.	"	28 17/64	28 17/64	
600	29 4/32	29 7/64	28 61/64	"	28 28/32	"	
700	"	29 3/32	"	"	"	28 28/32	Scale cracked at 1,050 lbs. Average thickness .407. Constant 15,356.
0	29 9/64	29 4/32	28 31/32	28 61/64	28 28/32	28 28/32	
800	29 4/32	29 3/32	28 30/32	28 30/32	28 28/32	28 27/64	
950	Pump valved choked; pressure released.						
0	29 9/64	29 4/32	28 31/32	28 31/32	28 28/32	28 28/64	
1250	27 30/32	30 17/64	22 3/16	34 12/32	25 28/32	30 12/32	After collapse.

FURNACE NO. 103.

	Tensile strength.	Elongation.	Reduction area.
Original plate	61.944 pounds.	26 per cent. in 8 inches.	
Sample from furnace	59,029 "	22.9 " " 6 " (broke at neck).	64.4 per cent.

1st. 4th. 7th Flats.

Pressure in lbs. per Square Inch.	Front.		Middle.		Back.		Remarks.
	Vert.	Hor.	Vert.	Hor.	Vert.	Hor.	
Original Diameter	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	
0	32 3/32	32 4/32	31 28/32	31 26/32	31 31/32	31 28/32	As collapse was deepening, second rip burst at 800 lbs. in circumference fracture 9 1-2 ins. long across weld. Fracture crystaline. Scale cracked at 1,200 lbs. Mean thickness U. S. .478. Constant 14,958.
500	32 3/32	32 3/32	"	31 23/32	31 30/32	31 27/32	
725	No dimensions taken.						
0	32 3/32	32 4/32	31 28/32	31 32/32	31 30/32	31 27/32	
1200	Gas plug blew out, releasing pressure suddenly.						
1300			32 3/32	31 19/32	31 19/32	31 28/32	

FURNACE NO. 104.

	Tensile strength.	Elongation.	Reduction area.
Original plate	62,392 pounds.	22 per cent. in 8 inches.	
Sample from furnace	59,829 "	30.2 " " 6 "	64.1 per cent.

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NO. 105.

NO. 106.

FURNACES AFTER TESTING TO DESTRUCTION.

1st. 4th. 7th Flats.

Pressure in lbs. per Square Inch.	Front.		Middle.		Back.		Remarks.
	Vert.	Hor.	Vert.	Hor.	Veit.	Hor.	
Original Diameter.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	
0	$29\frac{3}{32}$	$29\frac{3}{32}$	29	$28\frac{31}{32}$	$29\frac{6}{32}$	$29\frac{7}{32}$	Scale cracked at 1,110. Mean thickness (U. S. .460.
500	"	"	$28\frac{31}{32}$	"	$29\frac{11}{64}$	$29\frac{6}{32}$	
700	No dimensions taken.						Constant 13,586.
0	$29\frac{3}{32}$	$29\frac{3}{32}$	$28\frac{63}{64}$	$28\frac{31}{32}$	$29\frac{6}{32}$	$29\frac{7}{32}$	
1250	$29\frac{19}{64}$	$28\frac{1}{4}$			$29\frac{13}{32}$	$28\frac{31}{32}$	After collapse.

FURNACE NO. 105.

	Tensile strength.	Elongation.	Reduction Area.
Original plate	60,704 pounds,	29 per cent. in 8 inches.	
Sample from furnace	56,909 "	27 " " 6 "	63 4 per cent.

1st. 4th. 7th Flats.

Pressure in lbs. per Square Inch.	Front.		Middle.		Back.		Remarks.
	Vert.	Hor.	Vert.	Hor.	Vert.	Hor.	
Original Diameter.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	
0	$32\frac{23}{64}$	$32\frac{19}{64}$	$32\frac{2}{64}$	$32\frac{4}{64}$	$32\frac{19}{64}$	$32\frac{11}{64}$	Average thickness .384 ins. Scale commenced to crack 850 lbs.
400	$32\frac{23}{64}$	$32\frac{19}{64}$	32	$32\frac{3}{64}$	$32\frac{19}{64}$	$32\frac{19}{64}$	
600	"	"	"	"	"	"	Constant 13,778.
0	$32\frac{23}{64}$	$32\frac{19}{64}$	$32\frac{2}{64}$	$32\frac{4}{64}$	$32\frac{19}{64}$	$32\frac{13}{64}$	
962	$24\frac{13}{64}$	$32\frac{59}{64}$	$31\frac{39}{64}$	$32\frac{0}{32}$	$32\frac{4}{32}$	$32\frac{4}{32}$	After collapse.

FURNACE NO. 106.

	Tensile strength.	Elongation.	Reduction Area.
Original plate	62,168 pounds.	31 per cent. in 8 inches.	
Sample from furnace	60,180 "	30.2 " " 6 "	63 4 per cent.

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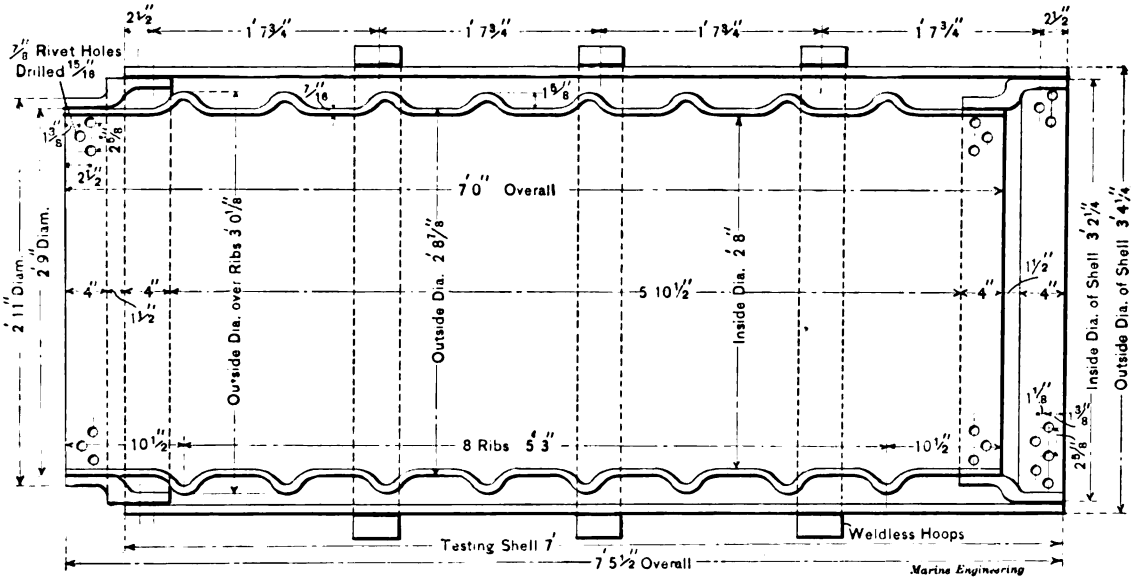
Points for taking the dimensions were marked on the plate by a center punch. In the preceding tables will be found the records of each furnace. The tests were eminently successful, and, by the way, are the only ones of the kind of which there is any record held in this country. The Board of Supervisors allowed the maker to use the same rule for determining the thickness and diameter for a given steam pressure as is laid down by the British Board of Trade, except that they required a factor of safety of 6 instead of 5 1-4 as is practiced in England. The formulæ are as follows:

Let C = constant.
T = thickness of plate in inches.
D = smallest outside diameter in inches.
P = working pressure, pounds per square inch.
P' = collapsing pressure, " " " "

Then $C = \frac{P'D}{6T}$ and $P = \frac{CT}{D}$



BROWN PATENT CORRUGATED FURNACE MOUNTED IN TESTING CYLINDER.

Views of the furnaces after the tests are given on the preceding pages. No. 106 showed a most unique collapse. The soft spot at the middle in the front end of the furnace was bulged out and the metal flowed cold, so that the corrugations came out in a flat surface. On No. 104, at a pressure of 1,200 pounds, a plug blew out in the side of the cylinder, relieving the pressure. The material of the furnace had evidently passed the elastic limit, because, when the pressure was again applied and 1,300 pounds reached, a fracture was discovered in one of the ribs, which burst before the entire pressure could be relieved. The other tests need no comment. The constant allowed by the Board is 14,000.

The entertainment offered to the guests was as hospitable as the tests were successful. The guests were taken from the shipyard to the Manufacturers' Club, where a fine banquet was provided under the auspices of Messrs. Worth, Baily and Company, General Dumont and the Supervising Board of Inspectors being the guests of honor. Many of those present were called upon for speeches by Mr. W. Wallace, marine engineer of John Brown and Company.

Propellers for British Cruisers.

In connection with the four first-class cruisers *Good Hope, King Alfred, Drake,* and *Leviathan,* a very interesting series of trials has been conducted, according to the *London Engineer.* These ships, of 500 feet length, 14,100 tons displacement, with Belleville boilers of about 72,000 square feet of heating surface and 2,310 square feet of grate surface, gave on full power trials the following results:

	I. H. P.	Speed knots.	Coal per hour per I. H. P.
Good Hope	31,119	23.05 m.m.	1.91
King Alfred	30,950	23.65 log	1.81
Drake	30,864	23.05 "	1.82
Leviathan	31,208	23.23 m.m.	1.94

The trials were first conducted with the *Drake* to determine the question of propeller efficiency. The loss in slip increased at a very rapid rate after 22 knots had been attained, and it was decided to change the original propellers, which had been proportioned as a result of tests made at the government experiment tank. The new propellers, first fitted to the *Drake,* had a greater ratio of surface to diameter, with the result that at full power the speed became 24 knots, or 1 knot in excess of the contract trial. Since then similarly-proportioned propellers have been ordered for all of the ships, so that each ship may have a speed of 1 knot over that recorded in this table. Corresponding propeller trials have also been carried out and are still in progress in connection with the vessels of the *County* class.

Racing Motor Boats.—Added interest will doubtless be taken in motor boats, due to the action of the New York yachtsmen forming the National Boat Association. Up to the present this type of racing has not been indulged in to much extent in this country, but now, under the encouragement of the National Association, interest in these races will be greatly increased.

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Marine Engineering

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EXCEPT in the Great Lakes yards, the outlook for new work in shipbuilding for the next year is not especially encouraging. In the Great Lakes district the yards have practically all the work they can take care of, and in some cases new work has been of necessity declined. Orders for this new tonnage have, of course, been predicated on a confidence in the continuance of the present commercial conditions during the next few years, and in the capacity of the modern ship to more than hold its own in competition with the less efficient ship of a decade or more ago. This, again, will depend on the general condition of business and industry as governed by the complex relations of demand and supply, inherent business confidence, crops and natural products, relations of labor and capital, etc., etc. Whatever the next few years may hold for the business of the country, the Great Lakes operators, by their recent orders, have signified their faith in a continuance, for some few years at least, of the present prosperous conditions.

With the yards on the Atlantic coast the condition is by no means as satisfactory. None of the yards can be considered full, and all are doubtless looking for more work. The conditions here are so different from those on the Lakes that no comparison between the two can be readily made without extended discussion. While the Coast builders would all be most gratified with such general conditions as have recently prevailed on the Lakes, and while all who are interested in maritime affairs will agree that such a condition is much to be desired, the problem remains—how to bring it about?

Is the condition one which calls for new legislation, for a readjustment of business methods, for an increase of confidence in ships and shipping as a field for investment, for a readjustment of prices for ships, or of the relations between the costs of labor, material, and administration, or for all these combined and with others perhaps unnamed? This is a question hardly to be answered in a few lines on the editorial pages. It is one where experts disagree, and where, after all, it comes largely to a matter of opinion. We have asked the question as one worthy of the most careful and exhaustive study on the part of all who are interested in maritime matters, and will only add the further thought that any study of this question which takes for the possible field of operation of our deep-water shipping anything less than the wide world of commerce will be only partial and unsatisfactory in its conclusions. We must take our place with other commercial nations, our solution of the problem must be influenced by the solutions which other nations are finding, and, in general, we must study the situation as a part of the world problem of commerce and commercial exchange.

WE would call the attention of our readers to the article published on another page and relating to the powering and propulsion of small boats. The problem of propeller design in particular is so little understood by the great body of amateurs who are interested in motor boats that we believe the relatively simple methods given will serve effectively to aid those who wish to give some study to this part of the problem. Quite recently a correspondent writes to learn if the speed at which the boat is going will have any great influence on the problem of design, or on the necessary size of propeller for a given power. The form of the equations given shows the close and vitally important relation between the size and the speed for a given power. It shows clearly that, with a given power, the higher the speed the smaller the propeller, and *vice versa*. Propeller

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design can never be reduced to the mere mechanical solution of a formula or series of formulæ. It must necessarily contain a very considerable element of judgment based on experience, and, at best, it is a problem intricate in character and in many details calling for more experimental work before the relations of various features are fully understood. For the purposes of those interested in small boats, however, relatively simpler means may be made to give satisfactory results, and to this end the article referred to has been prepared.

THE bill recently introduced into the Senate by Senator Frye and into the House by Representative Dalzell, looking to the appointment of a commission to suggest an entire revision of the code of rules and regulations relating to the construction and inspection of marine boilers, is one of the most important steps taken in recent years in connection with maritime legislation. The existing laws and the rules which are their interpretation have grown up piecemeal and without natural order or sequence. In many features contradictions and inconsistencies appear, and the correct interpretation is not always readily found. In many respects also the rules have fallen behind the advance of engineering progress, and revision and addition are needed in order to bring them into closer harmony with the best practice of the day, and with the possibilities of present-day methods and materials. The officers of the Board of Supervising Inspectors have long realized many of these facts, but have been hampered by the existing laws. We trust that the bill may speedily become a law and that the Commission will lose no time in setting itself to work on the task before it. The text of the bill provides that the Commission shall submit to the Secretary of the Treasury a preliminary report on or before November 1 next, that such report shall be freely furnished to all who may desire a copy, and that the Commission shall give an opportunity to all interested parties to submit any protest, suggestion, or recommendation in regard to changes or amendments that should, in their opinion, be made. After the careful consideration of such matter as may be thus presented, the Commission shall make a final report on or before February 1, 1904, for transmission to Congress. This is a promising programme, and we shall look with confidence for a revision of the laws relating to boiler design, construction, and inspection, which shall place the United States abreast of the best engineering practice and possibilities of the day.

WE should like to give a word of advice to our colleagues of the daily press; not that they will perhaps heed it, but that will not be our fault. There is hardly a day passes but that the daily press somewhere heralds some world-startling or epoch-making discovery in engineering or science. Ships in the form of some unthinkable monstrosity or propelled by some equally absurd propelling device are to cross the ocean in three days or less; some wonderful form of electric generator has been devised which is immediately to revolutionize the entire art of electrical engineering; some form of motor has been invented which, when sifted down to the ultimate analysis, means perpetual motion, or a new form of Keely motor; and so on *ad mirabilem*. In these particulars the situation has come to be such that no one in the least acquainted with engineering or science gives the slightest credence to any statements of this character which he may see in the daily press. Those who do not know may give a momentary credence, but only to find that they were following a blind teacher. It is not too much to say that in such matters the daily press is simply the laughing stock of the scientific and engineering fraternity; if such articles are read at all, it is simply as a joke.

As to how such "science fakes" are to be avoided, we can hardly undertake to say in all cases. An engineer on the staff of a large daily would often be of the greatest use in connection with such matters, and in the correct reporting of matters with an engineering bearing. The illustration of a marine boiler according to the ideas of the artist of a daily paper, and which we reproduced in our February number, is an illustration in point. Another way would be to consign to the waste basket all such reports as seem to bear on the marvellous in regard to engineering or science, on the principle that it may be better to fail to notice some meritorious discovery rather than to mislead, ninety-nine times in a hundred, the unknowing public and fill up space with absurd and impossible nonsense. How such absurdities originate would make an interesting study, but with that phase of the question we are not here concerned. We trust that our friends of the daily press will accept our reference to this matter in the kindly way in which it is intended, and we shall live in the hope that on the larger dailies the office of engineering and scientific expert may yet become one of established and recognized importance.

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THE SOLILOQUY OF A 3,000 H. P. TRIPLE.

BY C. A. MCALLISTER.

"Well, here I go again," mused the main engine of a coasting steamer one cold winter afternoon, as the ship passed out by Sandy Hook on one of her weekly trips to the southward. "I have been at this business steadily now for over six years, and I am getting a little bit tired of this eternal grind for a living. Here I have kept at it continually without a breakdown, and haven't had to stop once or ever caused delay by not being ready on time. True, on several occasions I have grown hot in the crank pins or in my guides, but that was because I was out of sorts on account of bad treatment. Well do I remember when they took me out on my first trial trip down the Delaware river. It was a bright morning in June and I was feeling like a colt, with my three thousand horses ready for the fray. My, how many complimentary things were said about me that day, especially when I kicked up my heels and made a spurt of 150 turns for an hour or so! Oh! the attention they gave me then! Those grooms were so anxious about my welfare that they were around me in swarms—felt of me all over, patted me, and, oh! such fine large doses of delicious oil as they did pour around my working parts; yes, and gave me a drink of good mellow old cylinder oil about every ten minutes. Then there were a lot of wise-looking youngsters standing around my cylinders, and they would take what they called indicator cards off three little nickel-plated instruments they had hitched up to me. Another youngster, who wore glasses and looked as if he would break in two if a puff of steam would strike him, had a big book in his hand and was putting down all kinds of figures from my gages. After a set of cards was taken the little boys would get together, look wise, make a lot of figures, and then the leader of them would whisper something to the superintendent of the shipyard, whereat that mogul would give a self-satisfied smile and announce to old man Jones, the president of our company, that I was doing a little better than 3,300. That, of course, tickled the old man, but I could feel in my frame that I wasn't doing a bit more than 3,000. Those draftsmen they send out on trial trips are regular wizards for jockeying figures to make them come out as they want them. When I got back to the wharf after the trial trip I was probably the 'chestiest' triple that ever came out of a shop. You see I was young and gullible, and such remarks as, 'Why, I never saw such a smooth-running engine'; 'Absolutely no vibrations'; 'We didn't have to use a drop of water on her, anywhere'; 'Never slowed down from start to finish'; 'The power is more evenly distributed among the three cylinders than I ever saw before'; 'You can throw her over with one finger on the reversing lever'; 'Stuffing boxes absolutely tight,' etc., nearly turned my cylinder heads. Since I have grown somewhat more accustomed to the ways of this hard, cruel world, I realize that any old scrap pile of an engine can get such bouquets as those thrown at them, providing the builders supply enough champagne to the guests.

"Alas and alack! but times have changed since that June morning. I no longer have such compliments thrown at me these days. Just think if it, that new red-headed First Assistant had the nerve to call me an old 'coffee mill' this afternoon when I was warming up at the wharf. I don't like that fellow anyhow; he has been chief of one of these millionaires' yachts all summer and his head is a little swollen. Just because there are not many polished brass bands around me, and no gallery with plate-glass windows where the passengers can come in and look me over, he thinks that I am a cheap skate. I don't believe he has ever stood a midwatch in a gale of wind in his whole life. He has a whole lot of things to learn yet. I wish they had promoted that young Second Assistant instead of running in that new fellow. The youngster is all right and tends to his business right up to the handle. He has only been with us two years now, but I feel easier when he is on watch than with any of the others. Of course, the old Chief is all right, but he doesn't take a watch now that we have a Third Assistant. The Chief and I have been together now ever since I first came out and we have never had a row yet. Here lately, though, the old gentleman is getting awfully stingy with me.

"There are many repairs I ought to have made in my pins and joints. The fact of the matter is, I need a vacation. I'm getting awfully tired of this everlasting thump in my after main bearing. They say I'm a little out of line, and that my bottom brass is worn down a trifle too much. Well, if they do not overhaul me a little and give me some rest and treatment I'll surprise them some day and break down out at sea. Then the owners will have something to kick about, if they have a nice large salvage bill to pay. Another thing I don't like is that they are getting too mean with their cylinder oil. I heard the Chief tell the young fellows to-day that there was too much oil on the crown sheets of the boilers the last trip and that they must cut down on my allowance. I don't see why they have to cut off my rations just to accommodate those boilers. I am sure the boilers never give me any consideration. Here lately every chance they get they cough up a lot of water and shoot it into me through my main steam pipe. They nearly choked me one night on the last trip up the coast. I wheezed and strangled so much that I thought for a time my heads would burst. What that little Second Assistant said to the water tender through the speaking tube was almost enough to melt the tube. That boy always looks after my interests and takes my side of the case.

"The boilers are getting lazy of late and don't furnish me as much steam as they used to. Then the engineeers try to take out their spite on me by jockeying around with the throttle and my cut-offs. If they would get in and read the riot act to those four boilers they might accomplish something. I'm getting a little old, but I'll give them the revolutions yet if they only keep the gas coming. Every once in a while I can hear the boilers grumbling among themselves about their tubes being stopped up, grease and dirt on their heating surfaces, poor coal in their furnaces, firemen that don't know their business, oily feed water, and a hundred-and-one other complaints they have. Boilers are very touchy things anyhow and growl at the slightest provocation. Glad I'm not a boiler; they're entirely too cranky!"

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"Huh!" chimed in the Independent Air Pump, who had been listening to the reverie of the Triple, "you needn't talk about crankiness; any one who has three cranks all going around at once has no kick coming to him." The Air Pump was one of these direct-acting fellows, and never lost an opportunity to guy the Triple about his cranks.

"Well, it's not becoming of you to criticise my cranks," retorted the Triple; "if you only had a couple of them yourself there would be no chance for you sneaking in your little half strokes as you have been doing recently, and knocking my vacuum down so that at times I think I am breathing out into the open air."

"Cranks wouldn't help your old vacuum any," said the Air Pump; "all you need to do is to wash out your condenser with a little soda and lye water once in a while. It's surprising how dirty some people can be; why, it's a wonder the quarantine officers don't hold you up some time."

"That will hold him for a while," chimed in the Main Feed Pump, who was not particularly friendly to the Triple. The boss of the engine room was plainly nettled by such persiflage, and as the screw propeller lifted out of the water considerably at that instant, he gave vent to his wrath by buzzing around at the rate of about five hundred revolutions a minute, which so startled the new First Assistant, who was on watch at the time, that he nearly dropped the pipe out of his mouth.

After he had been throttled down the old Triple could hardly contain his wrath at the impudence of what he considered to be such insignificant members of the engine-room family. Finally he launched forth in the following tirade:

"As for you, Mr. Feed Pump, you are simply so small and unimportant that any remarks you may make don't attract attention from any one. A pump which everybody places so little reliance upon that every ship has to carry several other pumps to do its work whenever it breaks down, and that happens pretty often, need not expect to be noticed by me. It's well they call you a 'duplex,' for I don't know of any one who practices more duplicity than you.

"As to your remarks about my dirty condenser, Mr. Independent Air Pump, I must say that they come in very poor grace. Of all the slovenly, dirty-looking objects around this engine room you are the limit. Look at you leaking water around your pump rods and spilling it all over the floor plates; look at that dirty streak of cylinder oil sizzling on your steam chest. You are getting entirely too frivolous lately and you don't half attend to your work, although every one remarks that you use up steam enough to run a dozen pumps; and it is common talk around the engine room that you have a regular cylinder-oil jag every day. Here lately they are giving you as much oil to drink as I have myself, and any one knows that I can stand it better than you. It was a sorry day for you Air Pumps when you had your apron strings, or links as we call them, cut from us main engines. You have become entirely too 'independent' for your own good. When we had you hitched to one of our crossheads you simply had to attend to business whether you wanted to or no, and it was precious little attention you ever got from any of these engineers or oilers. I wish we could get along without you entirely; and I really believe I could, as I have a connection from my condenser over to that little Auxiliary Feed Pump. He could pump the water out of my system and prevent me from having the dropsy. Why don't you behave yourself like that quiet little Contrifugal Circulator over there back of you? He goes at his business day in and day out and never gets gay like you do. If it wasn't for that faithful young fellow I believe I'd burn up when we strike the warm water south of Hatteras. He never complains about running up twice as fast as he is going now, whenever the sea water gets warm."

The Air Pump was getting vexed under this curtain lecture from old Triple, and, although he made no reply, every one noticed that he was getting sulky. Finally, to accentuate his feelings, he made three or four quick strokes and stopped dead still. Old Triple did not notice it for a moment or so, but finally he too had to slow down, so much so that he began to groan and his low-pressure valve ratted frightfully. This scared the new First Assistant nearly out of a year's growth, and the way he and the two oilers scampered around was a sight to behold. One of the oilers said that the Air Pump was simply balky and rushed up and struck it a sharp blow on the end of the valve chest. With a sudden groan the sulky pump started right up again, the needle on the vacuum gage went around to 25 inches, and old Triple resumed his former gait.

"I thought you could get along without me," tauntingly remarked the Air Pump. "So I can," replied old Triple, "but they wouldn't connect up the Auxiliary Feed. I'm glad they gave you that rap with the sledge, and hope you get a worse one the next time you attempt any of your dirty tricks." The First Assistant reported to the Chief the next day that one of the air pump valves had become dry on his watch and that the pump had stopped. Little did he know of the bad feeling existing between the main engine and the pump.

Very little more was said in the engine room that night. Old Triple had the sulks and kept up a continuous pound and thump all night. At four o'clock when his friend the Second Assistant came on watch, he was given a half pint of cylinder oil, which made the old boy feel so good all over that he stopped his pounding. The Second Assistant had directed the oiler to pump a little of the oil into the first receiver, and old Triple remarked: "There, that goes right to the spot," as he had a pain around his intermediate valve. As he fell to ruminating again he wondered why he could not have all the cylinder oil he wanted. "I know it is said to be a bad habit, but I don't see that it hurts me very much. I suppose that after a while they will have me signing a pledge to abstain from oil altogether, as these men do when they want to stop drinking liquor. If they had not given me the first drink of this oil I wouldn't have to break myself away from the habit now."

Just then the little shrill voice of the Main Speed Pump was heard: "Look out, you old toper, or the first thing you know they will be sending you to a Keeley Institute." "Well, I have been getting samples of the Black Lead (graphite) cure, so I presume I

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could stand the gold cure, but even that would be preferable to being compelled to work in the same room with such an insignificant shrimp as you," came back old Triple. "I'd rather be a shrimp than an old oil-soaked whale," chuckled the Feed Pump, and this remark raised a metallic laugh among the denizens of the engine room, at the expense of main engine, who restrained his rage, but became somewhat heated by taking an extra turn or so.

Hour after hour the time passed, and hardly a word was spoken; the Air Pump kept up a dignified silence; the Feed Pump would occasionally shout out something to try to amuse his companions, but Old Triple would pay no attention to him. The old fellow looked weary and was plainly not at his best, as his revolutions were not averaging much over 120. Occasionally he would break out into a rhythmic chant of "I-need-a-rest, I-need-a-rest, I-need-a-rest," and keep it up for an hour at a time. The impish Feed Pump would, on such occasions, arouse his ire by chanting in his quick, jerky voice: "O-give-us-a-rest, O-give-us-a-rest, O-give-us-a-rest," with the accent on the "us."

The Chief Engineer, who had been with Old Triple long enough to interpret some of his talk, was quite worried whenever he heard the main engine fall into these despondent fits, and the "I-need-a-rest" chant rather haunted him. Accordingly when the steamer arrived at her last stopping place on the outbound trip, he and the assistants gave Old Triple a thorough looking over, making many notes as to the condition of his various parts. These were embodied in a report to the Superintending Engineer, and forwarded by mail

On the homeward-bound trip Old Triple resumed his chanting, and as they were going out of port he would repeat: "It's-the-same-old-grind, it's-the-same-old-grind, it's-the-same-old-grind." One night when the First Assistant was on watch, the engine got so mad at things in general that he got hot in the after main bearing. Although they poured oil and water on it he refused to let it cool off until the Second Assistant came on watch. "I like to have fun with that red-headed chap who called me an 'old coffee mill,'" the Triple remarked, and then cooled down and ran as nicely as ever. He and the Air Pump were no longer on speaking terms, and each wore an air of haughty indifference to the other during the entire trip northward. The impudent Main Feed had broken down entirely the second night out, and the Auxiliary had taken his place. As he was a quiet, unassuming chap who attended strictly to his own business, there was very little gossip going on.

Old Triple mused as they were going up the bay that he would be wiped down when they got to the wharf, have some adjustments made to his crank pins, one of his top brasses scraped, and then in three days off he would start again on another monotonous trip. Much to his surprise, just after the jingle bell was sounded, the Chief announced that the ship was to be hauled off and given a month in which to make repairs at a machine shop. Old Triple's chanting and the Chief's report had had the desired effect.

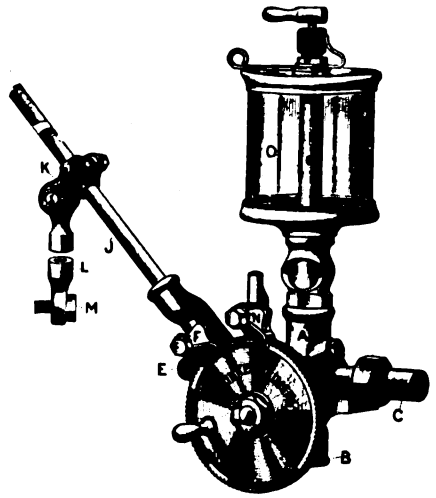
Moral: *All ye good seafaring engineers, learn to know your engines and try to understand their talk.*

ENGINEERING SPECIALTIES.

Mechanical Oil Cup.

A mechanical system of oil feed is generally considered necessary on all large engines, and a method of lubrication which was found, after experimenting, to be reliable and positive, is shown in the devices here illustrated, made by the Lunkenheimer Company, Cincinnati, Ohio. Motion may be taken for driving the mechanism from an eccentric rod or other moving part of the engine by means of the rod *J* and couplings *K* and *M*. The rod *J* operates the ratchet wheel *D* through the clutches *F* and *N*, and the motion is transmitted to the piston *E* by the crank-pin mechanism.

The ratchet wheel *D* is provided with a handle whereby it can be rotated by hand in case it is desirable to force a quantity of oil at any time, as, for example, when starting the engine. By moving the part *K* up



OIL FEED PUMP.

or down the rod, the stroke of the pump can be lengthened or shortened, as desired, thus regulating the amount of oil fed by the pump independent of the feed from the oil cup. The joints of the cup are tight, the sight-feed glass being packed so as to prevent the access of air that would have a tendency to cause the cup to feed after the engine had ceased running. This construction and the use of check valves in the pump prevent oil supply from flooding. The outlet *C* is piped to the steam pipe or chest of the engine, and the spring check valve should be placed as near the end of the pipe as possible, preferably into the steam pipe. The bottom of the pump body, *B*, is tapped with a 1-2-inch pipe thread to receive a stand so that it can be placed wherever desired. The pump is substantially constructed, the workmanship being first class, and, as the parts are made to jigs and templates, they can all be easily renewed, being perfectly interchangeable. The ratchet wheel *D* and pawls *F* and *N* are made of tool steel, tempered and hardened. All other metal parts about the pump are made of the very best hard bronze composition.

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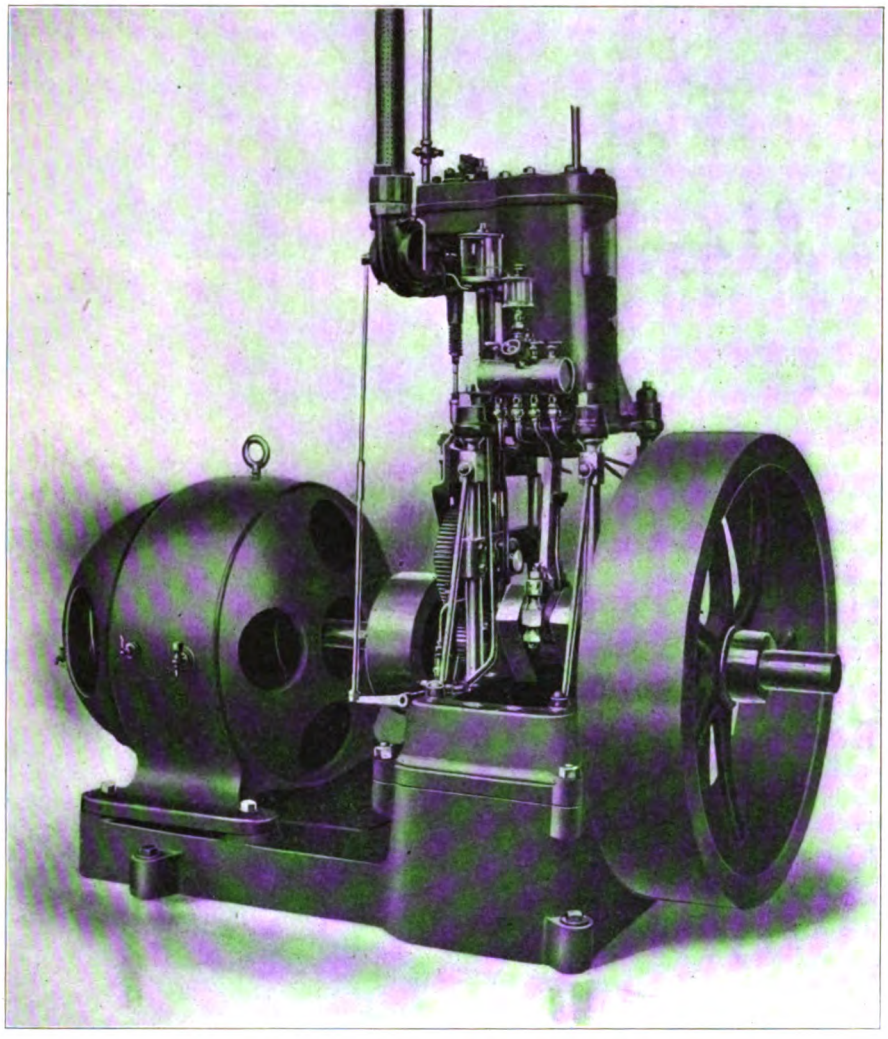
Oil Electric Generating Plant.

To produce electricity or any other power directly from fuel has been a problem for many engineers, and the resulting gasoline engine has given more or less satisfaction. For commercial use, however the gasoline engine is restricted because of heavy insurance rates. The other direct sources of heat are coal, natural gas, crude oil, or refined oil. The use of natural gas is, of course, limited to localities where it is produced; crude petroleum is difficult to volatilize and is not obtainable in every market. Up to the present much trouble has been encountered in using a refined oil such as kerosene, from the fact that an excess of oil or air in the mixture, and any variation in the temperature of the igniter, prevents continuous operation.

The engine here illustrated, built by the General Power Company, 81 Fulton street, New York, N. Y., uses kerosene oil as fuel, and it is claimed that all the obstacles have been overcome, as the methods of supplying and igniting oil are radically different than those heretofore used. Instead of the oil being admitted to the engine as a vapor or forced in as a liquid, it is drawn in in the liquid state, and the exact mixture of oil and air is at all times obtained by means of a micrometric measuring device. Kerosene is superior to gasoline or city gas in chemical uniformity. In the design of this engine, simplicity, reliability, strength, and lightness have been aimed at. It is evident from the illustration that no excess material has been used such as is seen in a gas engine, the design being more like the high-speed steam engine. The cylinder, which is water-jacketed, rests on columns of open-hearth steel diagonally braced. The journals are unusually large and special provision has been made for copious lubrication. The cover of the cylinder and valve chest is made in single casting. The shaft is carefully balanced and the connecting rod is of the marine type. The cam shaft is actuated by a vertical lay shaft which is connected to the crank shaft below and the cam shaft above by helical gears, and the governor is placed in the top of the lay shaft by which it is operated, the object being to permit close connection between the governor and the air and oil inlet valves. Speed regulation is accomplished by varying the amount of oil and air taken into the cylinder and not by the usual hit-and-miss device. The engine may be started and stopped with as



ELECTRIC GENERATOR DRIVEN BY AN OIL ENGINE.

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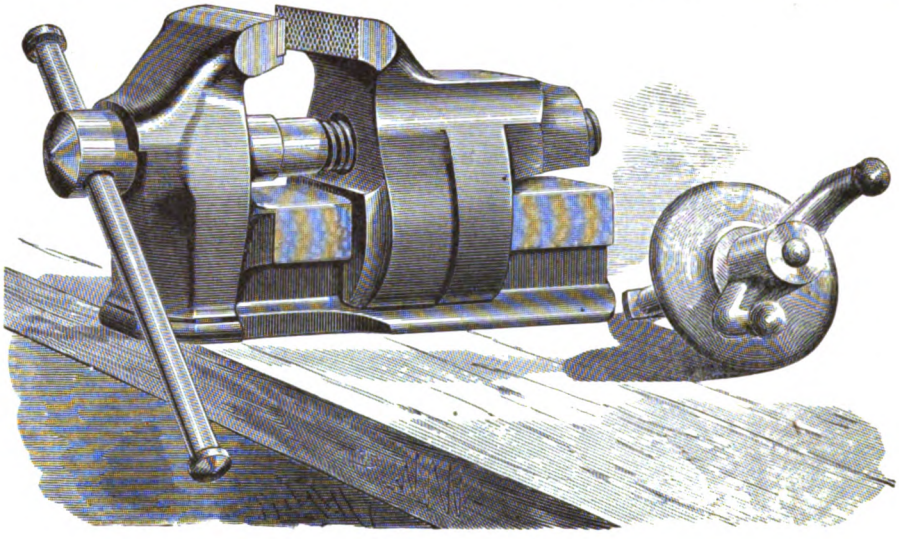
much ease as a steam engine, and is controllable under all conditions. The regulation is so accurate that when the engine is direct connected to a generator a constant voltage may be maintained with all degrees of load; in fact, these engines have run very successfully alternators connected in parallel.



HEAVY CHILLED BEAM VISE.

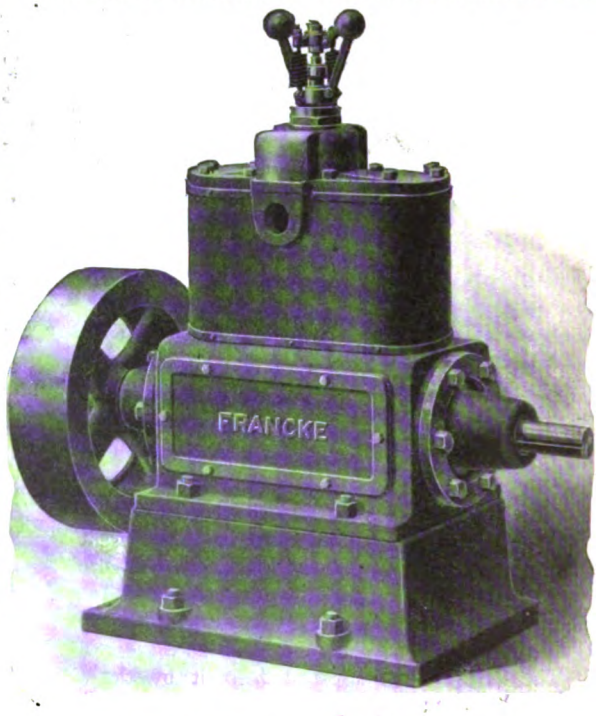
Heavy Chilled Beam Vise.

A vise which was designed and built specially to meet the requirements of machine-shop work has proved so satisfactory to the manufacturer in his own shop that it has been placed on the market. In its design and construction the following points were kept in mind: First of all, a vise must be sufficiently strong to allow of chipping or filing the work without the possibility of the vise breaking, and the inertia of the anvil should be sufficient to absorb the effects of the blows; the jaws should move parallel and freely, and when the screw is tightened the full power of the screw should be exerted on the work and not in overcoming the friction between the head and the movable jaw; all parts should be durable; and, lastly, the tool must be furnished at a reasonable price. These points are claimed to be embodied in the vise here illustrated. The jaws are steel faced by welding, and plenty of metal is used to secure strength in the proper place. The motion is direct and all sliding surfaces are chilled, thus parallel action is given, durability and increased strength secured. By making the vises with special machinery they are sold at a low price. They are made in five sizes, weighing from 15 to 125 pounds, with jaws of from 2 by 5-8 inches to 6 by 1 1-4 inches in dimension. For further particulars address the manufacturer, H. B. Smith Machine Company, Smithville, N. J.

Four-Ported Engine.

The Francke engine, herewith illustrated, is termed a four-ported engine, as it accomplishes with one valve steam distribution attained in a four-ported engine. The valve mechanism and engine are so simple in construction that the first cost is not higher than that of other first-class engines, while the highest grade of workmanship and material is maintained. The valve is simply a cylinder with a steam port on one side and an exhaust port on the other, turned on the outside to fit a bushing containing the ports leading to the cylinders, and on the inside to fit a tube containing the live steam ports. It is rotated by a pair of bevel gears from the shaft, running constantly in oil, and in all a very simple mechanism.

The valve is connected to the governor by means of a



DOUBLE SINGLE-ACTING ENGINE WITH REVOLVING VALVE.

substantial spindle which drives the governor and makes the valve and governor practically one integral part, the valve rising and falling with the motion of the governor in a ratio determined by the relative

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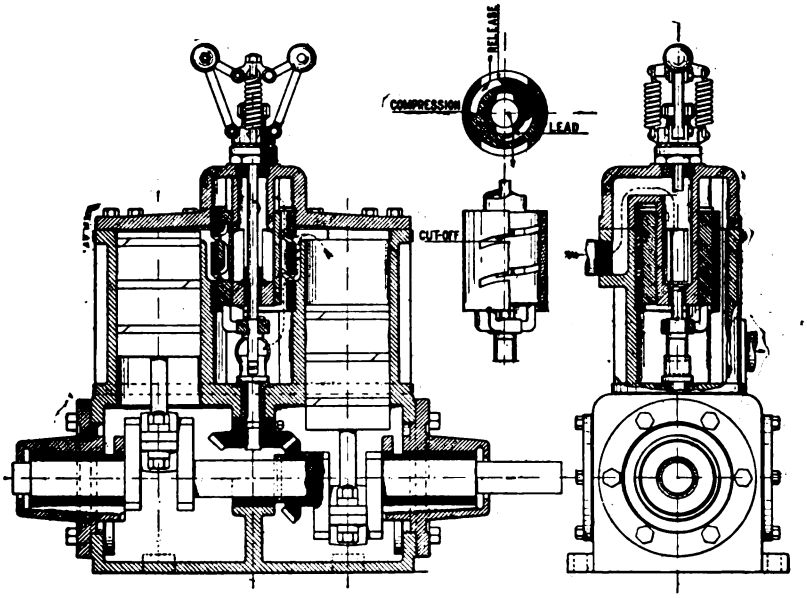
length of the governor arms. The steam port in the valve, one edge of which determines the lead given to the engine, is cut longitudinally with the valve on its inside diameter, so that the up-and-down motion imparted to the valve by the governor does not change the position of the valve with relation to the position of the piston, and the lead is maintained constant and may be changed at will without interfering with cut-off, release, or compression. On the outside diameter of the valve, the form of the port changes so that two ports are formed which have a slant corresponding to the slant of the ports cut in the bushing in which the valve rotates; consequently when the valve is raised by the action of the governor the cut-off takes place earlier, and when the valve is lowered it takes place later, without in any way changing the lead, release, or compression.

to the valve spindle itself, both the weight and the valve being driven by bevel gears from the main shaft, operating continually in oil. The governor's only function is to raise or lower the light-balanced valve according to the load of the engine. A close regulation is thus obtained with very light weights and springs and the simplest form of construction.

For lubrication, ring-oiling bearings are used for the shaft and an oil bath for the running gear in the crank case. A sight-feed lubricator takes care of the pistons and valves. The engine can be run at exceptionally high speed without undue wear or attention. Every engine is fully tested under steam before leaving the works, and is shipped ready to start. It is made in sizes from 5 to 25 horse power. This Francke engine is built in New Brunswick and sales are controlled by Thomas C. Maxfield, 120 Liberty street, New York, N. Y.



SECTION OF FOUR-PORTED ENGINE WITH REVOLVING VALVE.

The exhaust port in the valve is simply a slot cut longitudinally with the valve, one edge of which opens the port and the other edge closes it. As the valve edge which opens the port does not close it, which is the case in every reciprocal valve motion, it follows that the position of the opening edge may be set in exactly that position determined by the indicator to be the best for the speed at which the engine is run, without interfering with the lead, cut-off, or compression. Likewise the closing edge may be set to obtain the best compression for the economical use of steam, smooth running, and freedom from shock, which is so essential to high speeds, without interfering with the lead, cut-off, or release. Thus this single valve gives a four-valve distribution of the steam, which allows even the release and compression to be set independently of each other, which is impossible in even the best of the four-valve types. By referring to the cut it will be seen that the reciprocating parts of the conventional type of engine have been almost entirely eliminated, leaving only the two connecting rods and pistons, connected directly

16-Horse-Power Four-Cycle Marine Engine.

The 16-horse-power four-cycle marine engine made by the Lozier Motor Company, Plattsburg, N. Y., embodies many late improved ideas in marine gas-engine construction, and presents many features of merit. One of these is, that all parts needing attention are accessible and at the same time the engine has a symmetrical appearance. These engines are of the medium-speed type. The inlet and exhaust valves are of the same size, thus interchangeable, and are mechanically lifted, which gives positive motion. The engine is so designed that any valve may be removed by simply unscrewing the cover which is set in the head over same, without removing any piping. The ignition mechanism is very simple and of the "hammer-break" type. The firing plugs occupy a central position in the cylinder head and thus can be easily removed. The valve chambers and other parts requiring to be cooled are water-jacketed, the water being circulated by a rotary pump which has proven to be very satisfactory and is driven by a chain. Cooling water is conducted from one cylinder jacket to another

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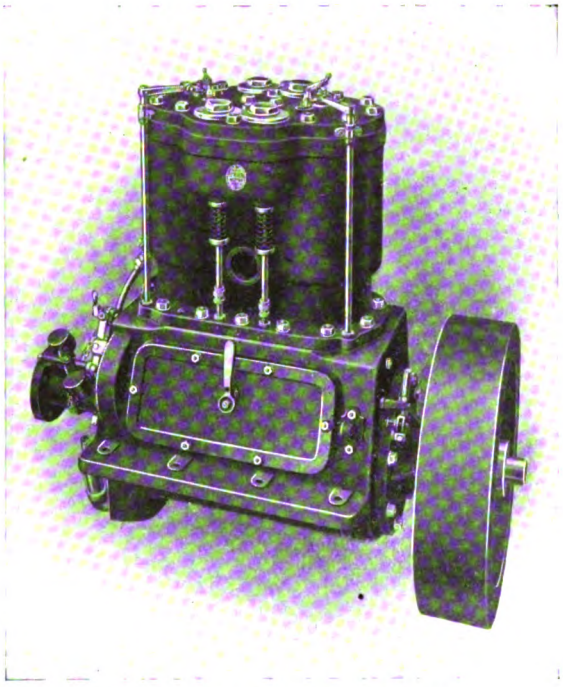
through a covered passage, thus doing away with the unsightly pipes; in fact, the engine requires but little piping. The oiling is accomplished by sight-feed oil cups.

The motor is regulated by a governor which varies the lift of the admission valve, thus throttling the gases close to the cylinder. It will hold in constant speed with full or light load, and in heavy seas will prevent any tendency toward racing. When full power is wanted the governor may be easily disengaged and the engine will make fully 20 horse power. In addition to the automatic governor there are several other means of controlling and regulating the engine. The exhaust valves may be lifted by means of a lever to relieve the com-



16-HORSE-POWER MARINE GASOLINE ENGINE.

pression and permit the engine to run slowly or the flywheel to be turned by hand. The position of the igniter cam shaft is adjusted by a small hand lever placed at the front of the engine. The motor may be further controlled by means of a butterfly throttle placed between the vaporizer and the inlet valves.

The material, construction, and workmanship are all high grade. The main bearings are bronze-bushed, and the cams, governing parts, and valve mechanism are case-hardened. The cylinder head for both engines is in one piece. The inlet and exhaust valves are on opposite sides of the engine, with a slight but equal overhang, giving a well-balanced appearance. The motor and reversing clutch are placed on one bed-plate, and next to this is the thrust-bearing bed, adjusted for go-ahead and astern motion.

Cruiser Contracts.—The Secretary of the Navy awarded contracts for building the armored cruisers *Washington* and *Tennessee* to the New York Shipbuilding Company, Camden, N. J., to Wm. Cramp and Sons' Ship and Engine Building Company, Philadelphia, the price being $4,035,000 each.

QUERIES AND ANSWERS.

Q. 122.—Please answer the following through the Marine Engineering:

1. What precautions are now taken to guard against galvanic action or corrosion on the interior of marine boilers?
2. What are the precautions taken to prevent scale deposits on the interior of boilers using salt water?
3. In using lake or river water in boilers what deposits are mostly to be feared and what precautions are taken to guard against them?
4. If you use well water in a boiler that is hard by reason of carbonate of lime or magnesia, how can it be made soft?

A. F.

A.—Corrosion is a somewhat broader term than galvanic action. Corrosion may be due to the chemical change known as oxidation or it may be due to the presence of an acid. Oxidation simply implies the chemical union between the metal and free oxygen. These two kinds of corrosion are, however, by no means independent, and are often combined in very complex ways. In order to understand galvanic or electro-chemical action a few explanations must be given.

Nearly all substances, and in particular metals and minerals, exist in a different electrical condition. Such a difference is often found not only between substances of different kinds, but also between similar substances at different temperatures or in different physical conditions, as, for example, between two pieces of iron or steel one of which has been heated or worked more than the other. Due to this difference of electrical condition there is a tendency to set up a flow of electricity from one to the other and at the same time to bring about certain chemical changes in connection with such an electrical current. The activity of such chemical reactions will depend very much upon the surroundings of the two bodies, and, in case they are immersed in a liquid chemically active toward one of them, there is great likelihood that the electro-chemical action will be brought about and will result in a continued destruction of one of the substances accompanied by a current of electricity around the circuit.

In a steam boiler the conditions for a more or less continued electro-chemical action may be fulfilled in a variety of ways. Parts of the structure of widely differing temperatures or of different physical or chemical compositions may provide the elements with a different electrical condition. Still more likely such a difference may be found between iron and its oxides, or between a particle of carbon in the steel and the surrounding metal, or between a bit of slag or other impurity and the surrounding metal. Copper also, either in the form of oxide or metal, would furnish a substance differing strongly from the iron. The exciting liquid is the water in the boiler, which, when salt and at high temperature, is capable of exercising a sufficiently marked chemical action to develop the electro-chemical reaction referred to above.

For the prevention of these chemical actions the causes must be either removed or neutralized. For reducing or preventing oxidation the presence of air in the feed water must be avoided by preventing, as far as possible, the entrance of water from overboard into the feed, or the possibility of the feed pump sucking air from the hot well. The piston rod of the low-pressure

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cylinder should also be kept well packed, so as to prevent the entrance of air during the exhaust stroke. To prevent acid corrosion the formation of acids must be prevented, as far as possible, and such as may form must be neutralized within the boiler. The chief substances from which acids might arise are the salts contained in sea water or various organic substances. We have thus an additional reason for keeping such substances out of the boiler as far as possible. In order to neutralize such acids as may be formed, bicarbonate of soda, or soda ash, as it is commonly called, may be used from time to time as necessary. To test the water the usual litmus test may be employed. Blue litmus paper turns red when dipped in water slightly acid, while if the water is alkaline it turns it blue. Instead of soda, dependence is often placed on the zinc slabs referred to below and employed to prevent electro-chemical action. These are gradually dissolved by hot salt water, forming zinc chloride, and this will tend to neutralize any acids and keep the water alkaline.

In order to prevent electro-chemical action, the causes noted above must be removed or neutralized as far as possible. To this end the following conditions should be fulfilled: (1) Causes liable to produce oxidation or the formation of other foreign compounds should be kept out of the boiler; (2) the water in the boiler should be made as nearly neutral or non-exciting relative to iron as possible. This will be attained by keeping it slightly alkaline rather than acid and by avoiding high densities. In addition to this means for reducing the causes a further important step should be taken, and this is (3) the provision of a substance which shall be electro-positive to iron; that is, so related to iron that the electro-chemical action, if any takes place, will result in the destruction of the protecting substance rather than of the iron. Such a substance is found in zinc, and its use is quite general and apparently beneficial. The action of zinc is thus seen to be twofold. By the formation of zinc chloride it will tend to keep the water alkaline and thus reduce the chemical activity, while at the same time if there is electro-chemical action it will attack the zinc rather than the iron.

In order to be thus effective, however, care must be taken to insure actual metallic contact between the zinc and the structure of the boiler. The zinc is usually in the form of rolled or cast slabs weighing eight to twelve pounds each. These may be placed in perforated sheet-metal baskets hung from the stays or attached to other portions of the boiler. Where the basket is attached to the boiler there should be bright metal contact and the attachment should be by screw joints, so that the separation of the two surfaces by the formation of scale or corrosion may be prevented. The zinc should also be connected to the basket by through bolts or other means which will insure continuous metallic contact.

In dealing with questions of this character the principal point is to understand as clearly as possible the causes of the corrosion or other difficulty, and then to take such steps as will most certainly insure the removal of such causes or their neutralization at the point of action.

(The other points will be answered later.—ED.)

Q. 123.—Will you kindly answer the following questions through your valuable paper:

(1) I am running feed water into the dome of a 5 by 7 Roberts boiler, through an economizer of my own make, at 260 degrees Fahr. If I extend my feed pipe down and back and forth over the fire and feed into the bottom leg (taking it out of the dome), will it work, or will it be better to feed in the dome at water line as usual?

(2) What is the best way to construct an ash siphon for lifting or blowing ashes out of the pit and overboard? G. W.

A.—(1) If you extend your feed pipe down and run it back and forth over the fire you make the feed pipe practically a part of the regular heating surface of the boiler, and it is doubtful if there would be any advantage in this. You might feed into the lower drum if you wish, direct from your economizer, although with this boiler and others of the water-tube type the usual arrangement is to feed into the upper drum. The usual arrangement of feeding from the economizer into the upper drum will probably prove most satisfactory, and we could hardly advise increasing the heating surface of the boiler proper in the way you suggest.

(2) As you doubtless know, there are two or three types of ash ejectors on the market which operate in the way you have in mind. A study of these will illustrate the points involved in the apparatus. Perhaps some of our readers may have had experience in fitting up in small size a simple device of this character, and if so we shall be glad to hear from them for the general benefit of those interested.

Q. 128.—Will you kindly inform me of the best way to deaden the sound of the exhaust of a two-cycle marine gasoline engine of four-horse power or larger? Is it possible to let the exhaust out under water, as some makers claim, similar to a four-cycle engine? Can the overflow water be allowed to intermingle with the exhaust in the muffler, both going out of the one outlet? L. A. C.

A.—One of the best ways to stop the noise is, as you suggest, running the exhaust under water, passing it first, however, through a muffler of from four to eight times the volume of the cylinder. This method is described in that chapter of Mr. Roberts' articles which treats on installation. Allowing a portion of the outlet water to pass into the exhaust pipe will help to deaden the noise, though not stop it entirely.

Q. 133.—Will you kindly answer the following questions. What are the government's requirements for the point at which a fusible plug should fuse? I have heard different fusing points. Also the area of steam and exhaust ports in proportion to size of cylinders. These questions are asked by inspectors for license. J. T. S.

A.—Answering the first part of your question, we would refer you to Section 25, Rule II of the Rules of the United States Board of Supervising Inspections of Steam Vessels, which is as follows: "The bronze casing of all fusible plugs, unless otherwise provided, shall have an external diameter of not less than that of a three-quarters of an inch gas or steam pipe screw tap, except when such plugs shall be used in the tubes of upright boilers plugs may be used with an external diameter of not less than that of a three-eighths of an inch gas or steam pipe screw tap (said plugs to conform in construction with plugs now authorized to be used by this board); and no such plugs shall be used unless the core of the plug is filled with good Banca tin from end to end of the bronze casing; and it shall be the duty of the inspectors to see that these plugs are so filled (with Banca tin) at each annual inspection."

The fusing temperature of Banca tin is about 455 degrees Fahrenheit.

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As to the second part of your question, would state that the area of ports is determined by the speed of piston, the speed allowed the steam through the ports, and the area of the piston. The ports should be of sufficient size so that the steam will not be throttled in passing into the cylinder, resulting in "wire-drawing"; neither should the ports be too large, lest the clearance spaces to the cylinders be correspondingly large. It has been found that high-pressure steam will not flow as rapidly as low-pressure steam without resulting in wire-drawing. As the piston speed varies at all portions of the stroke, the mean piston speed is taken and we may express the quantities in the form of an equation:

$$V\,A = v\,a, \text{ or}$$

$$a = \frac{V\,A}{v}$$

Where V = the number of strokes per minute × length of stroke in feet.

A = area of cylinder in square inches.

a = area of port in square inches.

v = velocity of steam through the port in feet per minute. This item is assumed, and, as above stated, is different for steam at different pressures. In practice it has been found that where the steam ports are used for exhaust as well as for admission, the velocity of the steam through the high-pressure port should not be more than about 5,800 feet per minute; the velocity through the intermediate port, 7,200 feet per minute; the velocity through the low-pressure port, about 8,600 feet per minute. Where a compound engine is used the above figures may be taken, only omitting that for the intermediate-pressure cylinder. These figures are good for ordinary practice, but where light high-speed engines are designed a higher speed is allowed for the steam passing through the intermediate- and low-pressure ports, say 8,600 and 11,500 respectively.

Q. 134.—Will you please answer the following question in your Queries and Answers column:

Supposing you were at sea on a steamer and the safety valve broke, also the steam gage. How could you tell the pressure on the boiler, and is there more than one way? G. C.

A.—The answer to a question of this kind depends entirely on the circumstances of the case, and on the outfit of spare parts, etc., in the store room. There should be a spare gage of some kind on board which could be attached in place of the broken one. If there were no such gage, a one-half inch pine connection might be connected to the boiler and the indicator attached with the heaviest spring in the outfit. Knowing the scale, this would serve to indicate the pressure. If there were several boilers in battery, and there was no occasion to work this one separately, there would be no particular need of a separate gage, and the pressure could be sufficiently shown by the gages on the other boilers.

It simply amounts to this: that to measure pressure you must have some suitable gage or instrument; and given such, it is simply a matter of attaching it suitably to the boiler in question.

Q. 135.—Will you kindly answer, in your valuable inquiry column, the following questions:

1. In case your main steam pipe broke off in flange, how would you bring ship in port?

2. How could I place a cylinder on frame, the lower end being rough? C. B.

A.—(1) To questions of this character there is no single or definite answer. Given an actual case with all its attendant circumstances and the resourceful engineer will usually find some way out of the difficulty; but with the simple statement that the steam pipe is broken in the flange we have before us only one item in a hundred which may affect the problem. Assuming that the flange alone is broken, and that it is separate from the pipe, it might be removed and a new one put on in its place, were such at hand. Again, it is perfectly possible that certain breaks might be repaired by a soft patch. Again, it might be perfectly possible to make a new flange from a spare piece of plate, or from a piece taken from the internal structure of the ship where it might be least missed.

A situation of this character can be readily analyzed down somewhat as follows: To get steam from the boiler to the steam chest a continuous and steam-tight pipe must be provided. You cannot ladle it in by the spoonful. If the pipe or connections are broken, repair may be effected in two ways, either by reinforcement or by substitution. Reinforcement means a patch or something of the kind. Substitution means a new piece. As to which of these is the more suitable, or as to how it is to be best carried out, can only be determined by a study of all the details of the case.

(2) It is not clear just what is intended by the question. If it means that the facing on the bottom of the cylinder where it is intended to rest on the frame is rough instead of smooth, then the problem is definite. As to how the cylinder could be placed on the frame, would depend on the means available for hoisting and handling such weights. As to how it should be secured there, which we assume to be the point of inquiry, the following suggestions may be made:

First make the facing on the bottom of the cylinder as smooth as practicable by chipping with a cold chisel. This will go far toward making a fit. If sufficient time is available for a good job here, nothing more will be required, and the fastening may be made by bolts in the usual manner. If there is not time to make a satisfactory fit, then a putty or cement of sal-ammoniac, sulphur, and iron borings, or glycerine, litharge, and iron borings, may be made and put on the top of the frame to fill in the open spaces. If these are large, steel wedges may be driven in to supplement the putty, and the bolt fastenings may be secured in the usual manner.

It is possible that the point of the question may have had reference to lining up a cylinder under the conditions specified. In such case the adjustment and lining up would proceed in the same manner and by the application of the same tests and by the use of the same appliances as in any case, and which for lack of space will not be described here without a further inquiry relating specifically to this operation.

Q. 136.—What is meant by the ductility of a boiler plate, and how is it determined? F. B.

A.—The ductility of a boiler plate is indicated by two results of the usual test which is made on the sample taken from the plate in question; chiefly by the *elongation*, and to some extent by the *reduction in area*. The percentage of elongation in 8 inches, the usual length of the sample between marks, is found by taking the total length between these marks just before rupture and subtracting from this the 8 inches or original length.

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This gives the total elongation, and this divided by 8 and reduced to per cent. will give the percentage elongation. Thus suppose the original length of 8 inches is laid off, and just before rupture this has extended to 10.2 inches. The total elongation in 8 inches is then 2.2 inches. This divided by 8 gives 27.5 per cent. as the percentage elongation.

The percentage reduction of area is found by subtracting the final area of the section at the point of fracture from the original area at the same point, dividing the difference by the latter and reducing to per cent. Thus if the original area is .72 square inch and the final area is .38 square inch, the total reduction is .34 and the percentage reduction is .34 ÷ .72 = 47.2 per cent.

The United States requirements for boiler plate are as follows:

"The sample must show, when tested, an elongation of at least 25 per cent. in a length of 2 inches for thickness up to 1-4 inch, inclusive; in a length of 4 inches for over 1-4 to 7-16, inclusive; in a length of six inches for all plates over 7-16 inch thickness and under 1 3-4 inches thickness.

"All steel plate of 1-2 inch thickness and under shall show a contraction of area of not less than 50 per cent. Steel plate over 1-2 inch in thickness up to 3-4 inch in thickness shall show a reduction of not less than 45 per cent. All steel plate over 3-4 inch thickness shall show a reduction of not less than 32.5 per cent."

Q. 137.—On board the steamer *S*—— the boilers were filled with fresh water, and the first day out at sea, after steaming twenty-four hours, the water showed three-quarters at the salinometer. Does this necessarily mean that there is that much salt in it, or does it only indicate the density of water which might be affected from other impurities besides salt? B. F. S.

A.—Assuming the observation and the instrument both accurate, the result simply indicates that the density of the water is 3-4 on the salinometer scale. The presumption is that this is due to the salts in sea water, of which ordinary salt forms the larger part, or usually about 75 to 80 per cent. It would be rare that anything except sea water could affect the density of the water in the boilers to the extent mentioned, and in such a case we should be inclined to suspect the condenser of leaking. Such a condition might very readily cause a rise in density, as observed, and it is on the whole the most likely explanation of the situation noted.

Q. 138.—Would you do me the favor of explaining the accompanying sketch taken from the inset of the Scotch boiler in your issue of December, 1902.
Per cent. for rivets, Lloyds'.
Strength of shell, Lloyds'.
Or can you tell me where I can get a book of Lloyds' rules.
Those figures don't agree with English B. T. Rules.
Plate section is correct.
U. S. Rules also.
Lloyds' (Haswell),

$$\frac{\text{Thickness} \times \text{Least per cent.} \times \text{Constant } 260}{\text{diameter shell in inches}} = P$$

$$\frac{23}{28}\left\{\frac{\text{Area rivets} \times \text{Rows} \times 1\ 3\text{-}4 \times 100}{\text{Pitch} \times \text{Thickness}}\right\} = \text{Per cent. Rivet Section}$$

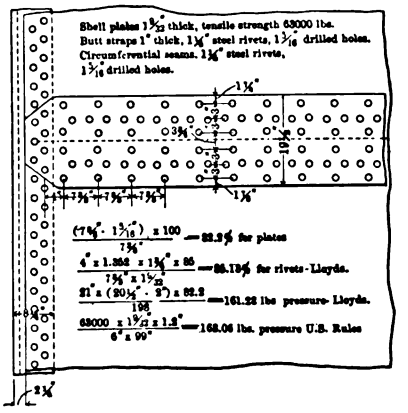
T. R.

A.—Lloyds' rule for per cent. of rivet strength is:

$$B = \frac{n \times a}{p \times t} \times 85$$

Where n = number of rivets.
a = sectional area of one rivet. When the rivet is in double shear use $1.75a$ instead of a.
p = pitch of rivet.
t = thickness of plate.

It is readily seen that $na \times 1.75$ gives the total sectional rivet area corresponding to one pitch, or p, while pt gives the corresponding sectional area of plate before



the holes are drilled. If the shearing strength of steel were the same as the tensile, then the numerator $na \times 1.75$ would represent the actual rivet strength in the same manner that pt represents the total original plate strength. Due to the fact, however, that the shearing strength is less per square inch than the tensile strength, the apparent rivet strength $na \times 1.75$ must be reduced to allow for this reduction in strength per square inch. Lloyds' rule assumes that the shearing strength is 85 per cent. of the tensile strength, and hence the numerator is multiplied by .85. The expression is then multiplied by 100 to give the answer in terms of per cent., and this brings the factor in the numerator to 85, as shown by the formula above. Comparison of this with the figures in the example quoted will show an entire agreement throughout.

Lloyds' rule for shell is as follows:

$$p = \frac{C\,(T - 2) \times B}{D}$$

Where D = mean diameter in inches.
T = thickness in *sixteenths of an inch.*
B = lowest percentage for longitudinal joint, either for plates or for rivets, as determined.
C = factor depending on style of longitudinal joint and with values as follows:
21, when joint has double butt straps of equal width.
20.25 when joint has double butt straps of unequal width.
19.5 when joint is lap instead of butt.

In the present case the value of C is 21. The thickness of the shell is 1 9-32. This is equal to 41 thirty-seconds and hence to 20 1-2 sixteenths.

The value of T is therefore 20 1-2. The value of B, as previously found, is 82.2 for the plates, and the value of D is 198. The formula results, therefore, as shown by the figures in the example.

The formulæ which you quote are older forms of the rules. In the first the thickness is expressed in inches

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and the constant is 2.60. This corresponds to a value 260 ÷ 12 or 21.66 with the thickness expressed in sixteenths. In the second formula the quantities are the same, except that 23 ÷ 28 is used instead of .85. The difference is small, 23 ÷ 28 being equal to .821.

A copy of Lloyds' rules can be obtained from the New York office of the Society, Kemble building, Whitehall street, New York, N. Y.

Q. 139.—Can you inform me where I can purchase a good practical book on how to determine the proper size of paddle wheels of stern and side-wheel steamers for Western rivers? Also, if there is no such book published, would you please give through the columns of MARINE ENGINEERING the formula for determining the size of such wheels? J. C.

A.—We regret to state that there is no book published exclusively dealing with this subject. *Practical Marine Engineering* has a few pages on Western river practice, and Seaton and Roundthwaite's *Pocketbook for Marine Engineers* contains rules for determining sizes according to the English practice. From the latter we quote as follows from pages 185 to 187 for feathering paddle wheels:

Let V = speed of vessel in knots.

S = percentage of slip, usually 15 to 25 per cent.

R = number of revolutions per minute.

D = diameter of wheel to axis of float.

N = number of floats in one wheel.

K = a constant, which for vessels plying in smooth water = 1,200, for seagoing steamers = 1,400, and for other craft which are required to stop and start frequently = 1,600; then,

$$D = V\frac{100 + S}{3.14 \times R}$$

$$N = \frac{60}{\sqrt{R}}$$

$$\text{Area of one float in square feet} = \frac{I.H.P. \times 33{,}000 \times K}{N \times (D \times R)^2}$$

When a vessel works in smooth water the immersion of the top edge of the float should not exceed

$$\frac{\text{Breadth of float}}{8}$$

Q. 140.—Will you kindly answer the following questions for me:

(1) Fifteen pounds of steam at atmospheric pressure are led into an open barrel containing 15 pounds of water at the boiling point. What will be the resulting temperature? What weight of water will be contained in the barrel?

(2) Which engine will have the greater thermal efficiency, a non-condensing engine taking steam at 120 pounds gage pressure and exhausting it at 3.3 pounds above the atmosphere, or a condensing engine taking steam at 80 pounds gage pressure and carrying a vacuum of 25 inches? H. E.

A.—(1) In the first place it would be impossible to lead 15 pounds of steam at atmospheric pressure into an open barrel. The volume of one pound of steam at atmospheric pressure is 26.36 cubic feet, therefore 15 pounds would occupy 395.4 cubic feet. Assuming, however, that the barrel was large enough to contain this and the 15 pounds of water, which, as you state, is at the boiling point, there would be no change of temperature and no condensation except that caused by radiation. If the barrel were open, as you state, the steam would escape; but let us assume that the barrel is closed and the pressure not changed. The heat in one pound of water above 32 degrees at atmospheric pressure is 180.9 and the latent heat of steam at this pressure is 965.7. If any of the latent heat in the steam should be transferred to the water, the steam would be condensed and the water evaporated, resulting in the same condition as previously. What would happen, unless the barrel were steam-jacketed or the temperature maintained at 212 degrees to prevent radiation, would be that the steam would gradually condense until the steam and water would be at atmospheric temperature. However, total condensation would not occur until absolute zero was reached. If the air in the barrel had been entirely displaced when the steam was admitted and if the steam did not contain any air, this condensation would create a perfect vacuum at absolute zero temperature. The sum of the weights of water and steam in the barrel will at all times be 30 pounds.

(2) Referring to steam tables which will be found in most engineering hand books, the total heat of steam at 120 pounds gage pressure is 1188.6, and at 3.3 pounds is 1149.8. From the same tables we also find that at 80 pounds gage steam pressure the total heat is 1180.6, and at 25 inches vacuum is 1122.5. Therefore, the thermal efficiency, regardless of radiation or cylinder condensation, is as follows:

	Non-Condensing.	Condensing.
a Admission pressure	120 lbs.	80 lbs.
b Total heat of steam at corresponding pressure	1188.6	1180.6
c Exhaust pressure	3.3 lbs.	25 in. vacuum
d Total heat of steam at exhaust pressure	1149.8	1122.5
e Loss=*a*—*d*	38.8	58.1
Thermal efficiency=*e*÷*a*	3.27	4.92

Thus the thermal efficiency of the condensing engine is about 50 per cent. greater than that of the non-condensing engine. The reason of this is that there is not as great a change in the heat of steam at a difference of, say, 5 pounds at high pressures as there is at a corresponding difference at low pressures. Other than thermal considerations, however, bring the efficiencies of the non-condensing and condensing engines to within about 25 per cent. of each other, in favor of the former type.

Q. 141.—Would you please state briefly through the MARINE ENGINEERING what are the advantages and disadvantages of multiple-expansion marine engines and high steam pressures? F. P.

A.—A general discussion of this question would require far more space than can be here afforded, and we can only briefly outline the chief points involved. The question is really twofold: What are the advantages and disadvantages of high steam pressures, and what are the advantages and disadvantages of multiple-expansion engines?

Regarding the first question, the advantages can all be comprised under the one head of increased economy. If the high-pressure steam undergoes what may be termed full expansion, then the expansion ratio will increase with the increase of pressure, the range of temperature through which the engine works will be increased, and the coal economy will be improved. That is, a horse power will be obtained for less coal than with lower pressure steam. On the other hand, if it be desired to sacrifice coal economy, then the expansion ratio can be reduced, the mean effective pressure increased, and the size of the engine for a given power decreased. This will result in an increased weight economy. High-pressure steam can, therefore, be made to give either greater coal economy or greater weight economy, or, in fact, any combination desired between the two.

The disadvantages may be summed up under the gen-

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eral head of greater care and greater wear and tear. High-pressure steam is of higher temperature, requires more carefully-packed joints, may give trouble with matters relating to lubrication, and, in general, requires more careful use than low-pressure steam. In none of these points, however, is the difficulty serious, and modern engineering methods are fully capable of taking care of steam up to, say, 300 pounds pressure, or covering the range of the prevailing practice of the day.

Regarding the second question, it results from the action between the cylinder walls and the expanding steam that economically only a very moderate degree of expansion can be carried out in any one cylinder, and that in consequence the total expansion must be broken up and carried on in a series of cylinders, in order to take full advantage of the possible economic gain. This loss of economy in a single cylinder is due to the excessive condensation of the steam by the cylinder walls, where any considerable degree of expansion is carried on in a single cylinder. To avoid this the operation must be split up and divided among a series of cylinders, and it thus results that the multiple-expansion engine is a necessity if full advantage is to be taken of high-pressure steam with regard to improved coal economy.

On the other hand, for marine purposes a multiple-crank engine is a practical necessity for mechanical reasons. It gives a more uniform turning moment on the shaft, provides for a more accurate balance of inertia forces, and avoids the difficulty in starting and handling which would be met with in a single-crank engine.

These various features of a multiple-expansion engine are so much a necessity that the other characteristics which might be urged as disadvantages have but little relative weight. It is true that a multiple-expansion engine has more parts, weighs more, costs more, and occupies more space than a simple engine of the same power; but for marine purposes in particular all these disadvantages are far more than outweighed by the advantages previously noted. So long as the reciprocating engine is the accepted marine type, it seems likely that it will be of the multiple-expansion form, using as high-pressure steam as the particular conditions justify.

United States Rules for Boilers.

Editor MARINE ENGINEERING:

In your Q. and A. columns in January issue I was interested in question 120, pertaining to boiler design. The question concerning thickness of shell gives factor of safety of 4 1-2 and strength of joint 80 per cent., also 1-16 inch to be added to shell for corrosion. The subsequent calculations are based on the United States Rules. While the question has been answered correctly, the premises in the shell computation are radically different from those in the United States Rules, in so far that the latter do not consider strength of joint, and their factor of safety is 6 plus 20 per cent. added to pressure for double riveting, practically making 5 the factor of safety in this case, and the shell thickness would then figure only 0.90 inch, omitting the 1-16 inch added for corrosion.

This addition for corrosion will, according to the United States Rules, incur a severe penalty, as, by a recent ruling of the United States Board of Supervising Inspectors, they have revived a dead letter law (Sec. 5, page 22), "Where flat surfaces exist . . . the spacing and distance apart of bracing and all other parts of the boiler must be so arranged *that all will be of not less strength than the shell.*"

Therefore, in Q. 120, if a boiler 12 feet diameter, tensile strength 60,000 pounds, and double riveted, be given a shell 1 1-16 inches thick, the calculation by United States Rules will give 177 pounds as the working pressure, and furnaces, stays, and all other parts will have to be designed for 177 pounds, even if it is desired to carry only 150 pounds working pressure. Of course the increase in size and weight will increase the cost.

Reviving the above-mentioned law has caused considerable comment and aggravation latterly, and constructors, engineers and boiler makers are anxiously looking forward to its repeal. H. L. E.

REMARKS.

The answer to the question referred to was framed to correspond to the terms of the question itself, and it was well known that the basis assumed in the question was quite different from that furnished by the United States Rules. As noted, the factor of safety in the latter for double riveting and drilled holes is 5 instead of 4 1-2, and it is rare to add such an allowance as 1-16 inch for corrosion.

The recent revival of the old rule referred to seems to be quite uncalled for, and, in the case of a boiler built under United States Rules, would severely penalize such a shell as that referred to in the question noted. We are indebted to our correspondent for noting this revival of an obsolete rule, and would join in the hope for its repeal by the Board of Supervising Inspectors.

Boilers of the British Navy.—The interesting results of the official steam trial of vessels of the British navy are given in *Engineering*, London. Six battleships, seven first-class cruisers and three twin-screw sloops, and two torpedo boats have undergone their steam trials during the year 1902. The battleships and cruisers are all fitted with Belleville water-tube boilers. The results of the 8-hour full-power trials on the battleships were that an indicated horse power was developed on one from 1.95 to 2.4 pounds of coal per hour; on the cruisers the average coal consumption on full-power trial was less, ranging from 1.82 to 2.12 pounds coal. Of the sloops the *Nerlin* is also fitted with Belleville boilers, and the pounds of coal burned per indicated horse power on a similar trial were 1.64 pounds; the *Odin*, the second of the three sloops, is fitted with the Babcock and Wilcox boilers, and the consumption was 1.57 pounds coal; the third sloop, *Fantome*, has Niclausse boilers, the results were 1.86 pounds of coal burned per indicated horse power. Thus it will be seen that the Babcock and Wilcox boilers give the best results of any of the types. The torpedo boats are supplied with Clydebank-Normand and Thornycroft boilers; the coal per I. H. P. was 2.455 and 2.62 pounds respectively. The Babcock and Wilcox boilers are to be installed on 11 vessels of the British navy, including 5 battleships, 4 first-class cruisers, and 2 second-class cruisers, with a total of 170,000 horse power.

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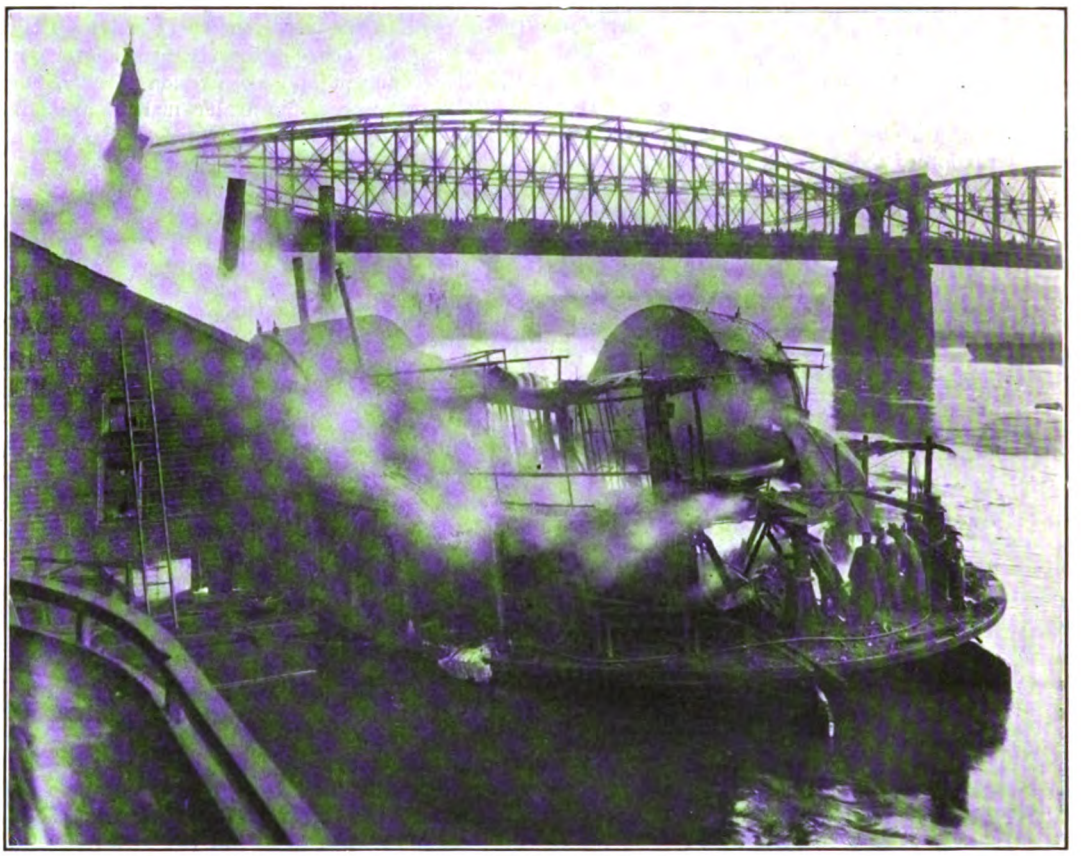
The Burned Steamer Columbia.

One of the finest equipped passenger packet boats on the Monongahela—the *Columbia*—owned by the Pittsburg and Brownsville Packet Company, was totally destroyed by fire on January 16, 1903. The *Columbia* came in to the wharf of the company in the morning and was due to leave at four o'clock that afternoon. At two P.M. fire broke out and the flames quickly spread from end to end and destroyed everything above deck.

The cause of the fire is unknown, but it is presumed to be the result of boiling tar catching fire. The fire was a most spectacular one, and was witnessed by thousands from the bridge, shore, and hillsides. The fire also damaged the wharf boat to which the *Columbia* was moored. The vessel was built at Brownsville in 1901 and was valued at $50,000. The machinery and hull may be repaired, but the loss will amount to $25,000 and is not covered by insurance.



MONONGAHELA RIVER STEAMER COLUMBIA, BURNED AT PITTSBURG.

PERSONALS.

Mr. Chester D. Hubbard, who had partial charge of the electrical equipment at the Newport News Shipbuilding and Dry-Dock Company, will take complete charge of the electrical plant and the equipment of ships at the Bath Iron Works, Bath, Me.

The firm of Herreshoff and Wells, Naval Architects and Engineers, New York, N. Y., has been dissolved and Mr. Theodore D. Wells, of that firm, has gone into partnership with Mr. H. C. Wintringham, Naval Architect, 32 Broadway, New York, N. Y.

William Stevenson has been made chief draftsman of the hull department of the Townsend-Downey Shipbuilding Company, Mariner Harbor, New York, N. Y.

At the annual meeting of the Marine Engineers' Beneficial Association, held at Washington in January, all the officers were re-elected for the ensuing year. They are as follows: President, Geo. Uhler; vice-president, Frank A. Jones; second vice-president, Evans I. Jenkins; secretary, Geo. A. Grubb; treasurer, Albert L. Jones; advisory board, Joseph Brooks, John McG. Sterritt, William Scheffer.

Austin E. Overman, who formerly held a position as draftsman with the William R. Trigg Company, Richmond, Va., has taken a position in the drafting room of the New York Shipbuilding Company, Camden, N. J.

James A. Bimson has been appointed chief draftsman of the engineering department of the Bath Iron Works.

Guy A. Jackson, formerly in charge of the construction of the Standard Oil Company barge *No. 93*, at A. Sewall Company, Bath, Me., has accepted a position with the Eastern Shipbuilding Company, Groton, Conn., as foreman on one of the large passenger boats under construction there.

Lieutenant Commander F. C. Bowers, U. S. N., succeeds, at the Bath Iron Works, Rear Admiral Harrie Webster, who was retired this month.

Wesley B. Smith, former quartermaster at the Wm. Cramp and Sons' Ship and Engine Building Company, Philadelphia, Pa., has accepted a position as master steam fitter at the works of the Fore River Ship and Engine Company, Quincy, Mass.

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TECHNICAL PUBLICATIONS.

Marine Almanac, 1903. Edited by Mittheilungen aus dem Gebiete des Seewesens. Size 3 1-2 by 5 1-4 inches. Pp. 588, with marginal index, blank sheets for notes, and many illustrations. Gerold and Co., Vienna, Austria. Price 4 1-4 marks.

The constant growth of naval armaments calls for an increasing dependence on statistical information, and among the various hand books prepared with this end in view, none perhaps stands higher than the present publication, having reference to accuracy, condensation, and convenience of size for ready reference. It is prepared yearly under the immediate auspices of the Austrian Department of Marine, and, while primarily intended for German-speaking peoples, it has justly become a standard book of reference for all topics relating to the subjects of which it treats.

Aside from the calendar and other miscellaneous information, the subject matter proper is given under five divisions.

Part I contains a collection of tables of weights and measures as used in various countries, with tables for the reduction of English measures to metric and *vice versa*. For the English reader these tables will be of value as furnishing a ready means of converting the various data given elsewhere in the book into measures with which he is familiar.

Part II consists of a compendium of laws and regulations relating to the Austrian naval personnel and to the general administration of Austrian naval affairs. This section will be of interest only to those directly concerned, or to the general student of naval administration in its minor details.

Part III gives in tabular form the usual statistical matter relating to the naval ordnance of the various maritime nations.

Part IV gives in tabular form the usual matter relating to the characteristics and leading particulars of the ships belonging to the various naval powers. The tabular matter covers 162 pages and is followed by 139 pages of line drawings giving in semi-diagrammatic form representations of the character and distribution of the armor and battery. This in turn is followed by a squadron list of the various naval powers and by a general index of all ships included in the section. This part of the book forms the section of greatest value and general interest, and seems to have been prepared with the usual accuracy and care.

Part V contains the Austrian navy list and has in consequence no especial interest for the general reader.

This little hand book of naval information has gained an assured place in the literature of the subject and it may be cordially commended to all interested as an accurate and authoritative collection of data and general information relating to the ships and armaments of all naval powers.

Steam Power Plants, Their Design and Construction. By Henry C. Meyer, Jr., M.E. Size 6 by 9 1-2 inches. Pp. 160. With 65 illustrations. Price $2. The McGraw Publishing Company, 114 Liberty street, New York, N. Y.

This book is written especially for engineers and others in charge of power plants, who may be called upon to design or purchase a plant or parts of it when their knowledge of machinery is more or less limited and when they are unable to obtain the advice of a consulting engineer. The book is a revised reprint of a series of articles which appeared in the *Engineering Record*, and the illustrations, most of which are insets, are taken from cuts which were published in that periodical. They represent a great variety of designs of power plants and many of the largest ones in the country. The pages tell of the designing of steam-power plants, of propellers and designs of boilers and engines, and sets of specifications for same. The subjects of steam and water piping auxiliaries, including feed-water heaters and economics, are dealt with, and the concluding chapters take up mechanical drafting, construction and design of chimneys, and problems of cold-water supply and purification. It is not claimed by the author that the services of a competent engineer should be dispensed with in designing a new plant by the use of this book, but so many plants are designed without such professional talent that the book is especially recommended to those of this class. To the expert the book claims only to present in accessible and convenient form data that are useful in his profession. The text is explanatory of the various problems met with in power-plant construction, steam-engine designing, and gives rules and formulæ for determining sizes and capacity of units. The illustrations form a valuable record of what has been done in this line, and, altogether, the book is a valuable one for all interested in power plants.

The Steam Turbine. By Robert M. Nielson. Size 5 by 8 1-2 inches. Pp. 163, with 145 figures in the text and 9 full-page plates. Longmans, Green and Co., London and New York. Price $2.50.

The author believes that the steam turbine is likely to be used to an increasing extent in the future, and that it has already assumed an importance which may well justify the preparation of a work dealing with the subject. He has therefore endeavored to combine in one connected treatment some discussion of the steam turbine historically, theoretically, and practically, and in the latter connection it has been his purpose to describe not only the principal parts of the leading types of steam turbine, but also the small details which in such cases have so large an influence in determining the success or failure of the turbine as a whole. As an aid to the discussion of the theory of the steam turbine from the thermodynamic point of view, a chapter has been added on temperature-entropy diagrams and their application to such motors. The results of a large series of tests are also given, care having been taken to make the values given as accurate as possible.

As the first extended book on the steam turbine this volume doubtless heads a long and growing list of future works. The fact that the turbine has come forward to a place meriting the recognition of a special book is an index of the growth during the past few years in its status as a prime mover. The author has a most timely subject for a new and interesting discussion, and he has well improved his opportunities. The style is good, and the book, without pretending to give any extended discussion of the theory of the turbine, does nevertheless give such a combination of the theoretical and practical as will be most useful to the general engi-

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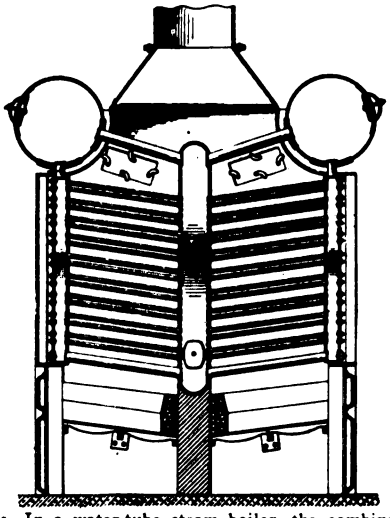
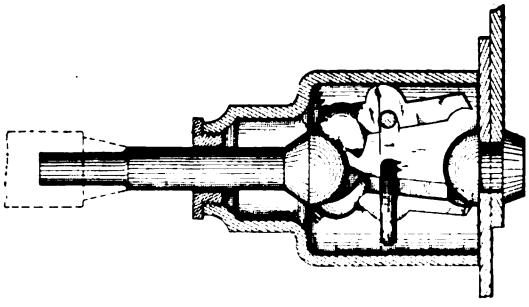
neering reader who is interested in this subject. Regarding application to marine propulsion, the marine engineer will perhaps wish for relatively more space. Eleven pages is an unduly small part of the book in which to discuss the special features of this field of application. While the leading types of turbines are supposed to be described, the Curtis in the United States, as represented on the yacht *Revolution,* is not noted and possibly was not known. Naturally the Parsons and De Laval came in for chief mention, or more particularly the former, as representing the type best known to the author and regarding which data were more readily obtainable. The book may be commended to all interested in the steam turbine as a prime mover, and its careful perusal will give a very excellent idea of the present condition of the turbine as a machine, and a good understanding of the principles on which it is operated and through which improvements must be sought.

SELECTED MARINE PATENTS.

714,530. WATER-TUBE STEAM BOILER. PATRICK J. SWEENEY, ELIZABETH, N. J.



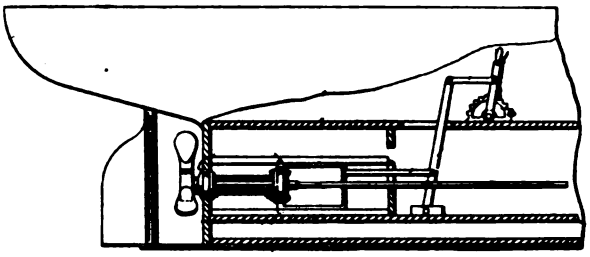
Claim.—1. In a water-tube steam boiler, the combination, with a rectangular casing, having two opposite sides, converging at the top and provided with doors to form the sides, of front and rear headers, an intermediate header having its interior and exterior surfaces corrugated, inclined water tubes connecting said headers, said headers converging at their upper portions in conformity with said casing, fire chambers below said water tubes, said water tubes being in regular vertical arrangement at the lower portions of said headers, to form channels for the products of combustion, and being in irregular vertical arrangement relatively to said channels at the upper converging portions of said headers. Three claims.



717,624. RIVET-CALKING TOOL. PATRICK J. SWEENEY, ELIZABETH, N. J.

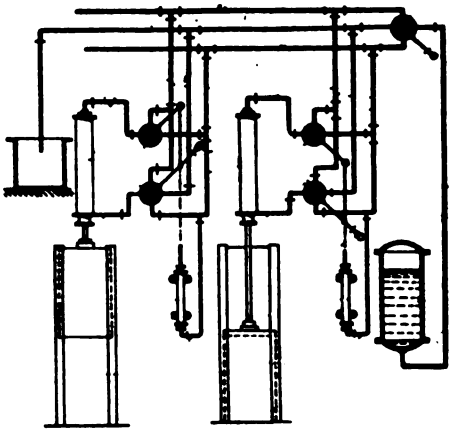
Claim.—1. A rivet-calking tool, comprising an exterior shell or casing, open at its lower end for receiving the rivet to be calked, a plurality of movable calking hammers in said casing arranged to receive the rivet head between them, and means for simultaneously operating said calking hammers into and out of contact with said rivet head, substantially as set forth. Four claims.

718,881. PROPELLER WHEEL. ORA E. SARR, CEYLON, OHIO, ASSIGNOR OF ONE-HALF TO DELLA SARR, CEYLON, OHIO.



Claim.—1. In a screw propeller, the propeller shaft, spaced propeller blades movably supported upon said shaft, spaced tracks parallel to said shaft, a frame slidably disposed between said tracks and enclosing said shaft, a hub slidable upon said shaft and revolubly disposed within said frame, rods connecting said hub and said propeller blades, and means for adjusting said frame and hub longitudinally of said shaft, whereby the pitch of said blades will be simultaneously and correspondingly altered. Eleven claims.

718,973. MEANS FOR OPERATING BULKHEAD DOORS. ALARD DU BOIS-REYMOND, BERLIN, GERMANY, ASSIGNOR TO NORDDEUTSCHER LLOYD, BREMEN, GERMANY.



Claim.—1. In an arrangement for simultaneously operating several bulkhead doors the combination with a common controlling valve, of a hydraulic cylinder operatively fitted to each door, means for connecting one end of said cylinder with either of a pair of mains leading to the controlling valve and the opposite end of said cylinder with either of the said pair of mains or with an exhaust pipe.

2. In an arrangement for simultaneously operating several bulkhead doors the combination with a common controlling valve, of a hydraulic cylinder arranged to operate each door, pipes leading from either end of said cylinder, and a pair of valves connected to said pipes and adapted to switch one of said pipes onto either of a pair of mains leading to the controlling valve and the other of said pipes onto either of the said mains or onto an exhaust pipe. Nine claims.

719,002. COMPOUND FOR REMOVING SCALE FROM STEAM BOILERS. JOHN N. HENDERSON, NEW ORLEANS, LA., ASSIGNOR TO EDWARD CUNNINGHAM, NEW ORLEANS, LA.

Claim.—A compound for removing scale from steam boilers composed of the following ingredients; parched ground coffee, extract of logwood, blood meal, salt, all thoroughly mixed with water. One claim.

719,172. PROPELLER. ARTHUR DE BAUSSET, NEW YORK, N. Y., ASSIGNOR TO HIMSELF AND CHAS. A. McCREADY, NEW YORK, N. Y.

Claim.—1. The combination with a shaft and propeller mounted thereon, of an open-ended cylinder receiving the propeller and in which the same is adapted to be rotated, a cylinder surrounding the aforesaid cylinder with an appreciable annular space between the cylinders, the outer cylinder being open at one end and closed at the other end, bearings for the said shaft, and devices maintaining the cylinders in a fixed relation to one another. Two claims.

719,225. REVERSIBLE PROPELLER. JOHAN V. JOHANSSON, SKRYSTA, HAMMAR, SWEDEN.

Claim.—1. In a propeller the combination of a shaft, a slide fastened thereto, said slide having a plane surface with a flange projected from one side thereof, the slide also having a transverse slot therein, a propeller blade, a quadrant on said blade and lying on the said plane surface of the slide, a pin attached to the quadrant and playing in the slot of the slide, the side edges

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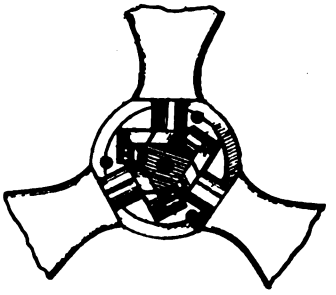
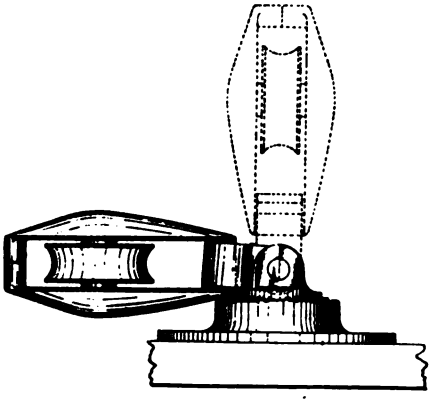
of the quadrant being arranged to bear against the flange of the



slide as the blade is thrown fom one position to another, and a hub in which the blade is mounted to turn. Two claims.

719,124. SHEET LEADER BLOCK. WILLIAM H. MARSHALL, WAKEFIELD, MASS., ASSIGNOR OF ONE-HALF TO THE MARINE HARDWARE COMPANY, A CORPORATION OF MAINE.



Claim.—1. In a sheet leader block the base-plate provided with the substantially vertical annular flange *e*; a plug rotatably supported by the base-plate within said flange; a sheave frame and pulley; and a pivotal connection between the plug and the sheave frame. Two claims.

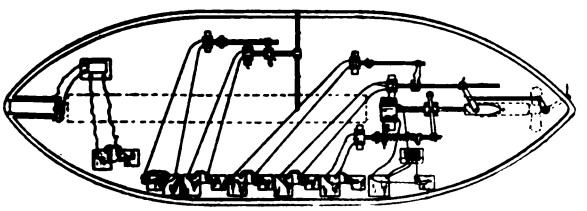
719,235. VENTILATION OF SUBMARINE BOATS. SIMON LAKE, BRIDGEPORT, CONN.

Claim.—1. In a submarine boat, the combination with a ventilating tube or passage communicating with the interior of the latter and opening outwardly above the same, of an outwardly-opening, spring-pressed check valve in said tube or passage located below its outer end, a chamber permanently open in its upper portion being formed above the seat of said valve and adapted to retain water entering the same, whereby the weight of the water serves to press said valve to its seat and to automatically hold it closed. Four claims.

719,316. INFLATING DEVICE FOR LIFE BELTS. JOHN EWING, JR., RICHMOND, CANADA.

Claim.—1. In an inflating device for collapsible life belts, the combination with the gas-generating chamber having a suitable opening thereinto, of a stopple having an eyelet or staple attached to its under side and designed to close the said opening, a bag or tube of porous material closed at each end, and designed to contain a gas-producing constituent, a string attached to the bag at one end and to the said staple at the other. Five claims.

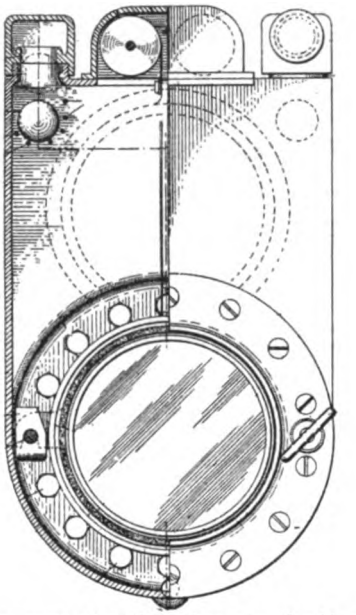
719,405. APPLIANCE FOR ELECTRICALLY OPERATING VESSELS AND TORPEDOES FROM A DISTANCE. LIDA WILSON, BROOKLYN, N. Y.



Claim.—1 The combination, with a movable vessel, of a series of electric motors for operating the propeller, the steering gear, the ballast shifter, and other required agencies, an electric battery or batteries upon the vessel for operating such motors, a circuit and circuit-closing mechanism connecting each of such motors separately with the battery, a series of wireless receivers of electricity each having means actuated thereby and connected with one of the circuit-closing mechanisms, and a corresponding series of wireless transmitters of electricity, such receivers and transmitters being mutually sympathetically synchronized in unison in pairs, whereby any of the said motors may be operated at pleasure from a convenient distance. Four claims.

719,416. VENTILATING PORT FOR VESSELS. JOSHUA W. ATLEE, RIVERTON, N. J.

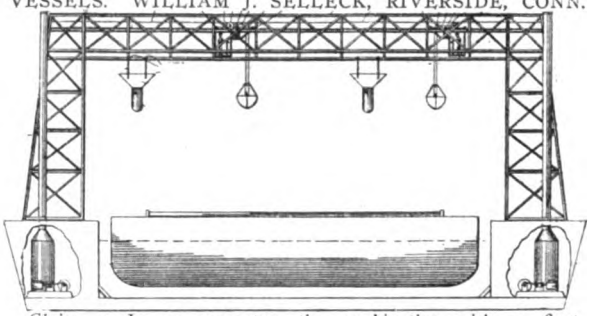
Claim.—1. In a ventilating port for vessels, a casing comprising inner and outer plates having openings to admit light and



air, a glass or cover adapted to close one of said openings and be retained in position within said casing at its upper portion when not in use, openings in the upper portion of said casing for the admission of air and an opening at the lowest portion of said casing communicating with the exterior of the vessel and adapted to carry off entrapped water.

2. In a ventilating port for vessels, a casing comprising inner and outer plates, having openings to admit light and air and being extended upwardly to form a receptacle for the glass when not in use, a glass or cover adapted to close one of said openings, secondary openings in the upper corners of said casing and float valves retained in said corners and adapted to close said openings to prevent the ingress of water. Eight claims.

719,517. APPARATUS FOR LOADING OR UNLOADING VESSELS. WILLIAM J. SELLECK, RIVERSIDE, CONN.

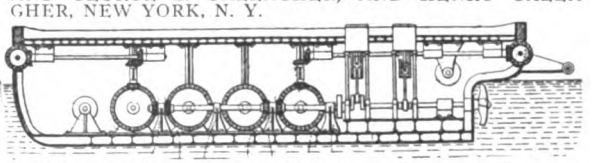


Claim.—1. In an apparatus, the combination with a floating vessel, of a bridge extending longitudinally above the vessel, a traveling crane guided on said bridge, and buoyant supports beneath the ends of said bridge, located in alignment with the bow and stern of the vessel. Thirteen claims.

719,654. MARINE LIFE-PRESERVER. JOHN EWING, JR., RICHMOND, CANADA.

Claim.—1. A marine life-preserver comprising a flexible casing adapted to be inflated, a partition dividing off a part of said casing to form a gas-generating chamber, said partition having a gas passage therethrough, and a cap closing an opening to said gas-generating chamber, said cap being adapted to admit water and to prevent the escape of gas. Five claims.

719,907. CANAL-BOAT PROPULSION. JOSEPH C. TONE, IRONDEQUOIT, N. Y., ASSIGNOR TO HIMSELF AND GEORGE S. GALLAGHER, AND HENRY GALLAGHER, NEW YORK, N. Y.



Claim.—1. The combination with the power boat and the engine thereof, of a series of large sheaves or rollers in line longitudinally of the boat with their axial centers in substantially the same plane, and devices substantially as shown and described for rotating the said series of sheaves simultaneously

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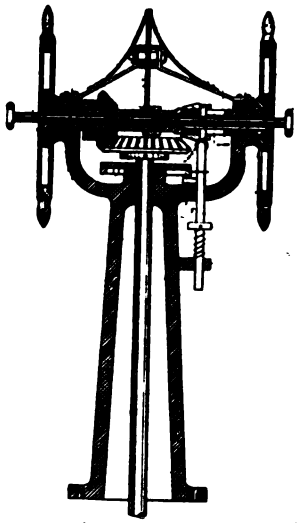
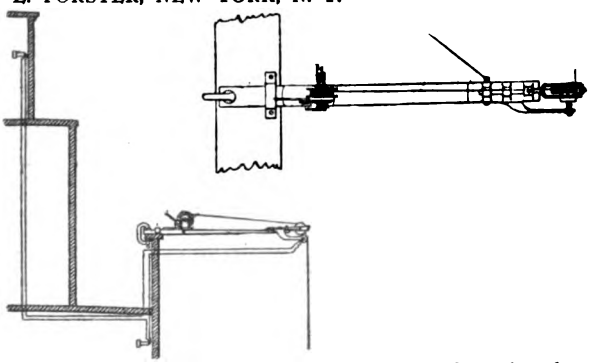
and in two sets in opposite directions by the engine, and a rope or chain passing over and alternately under the respective sheaves. Four claims.

719,869. STEERING APPARATUS. DANIEL W. RANTINE, BROOKLYN, N. Y.



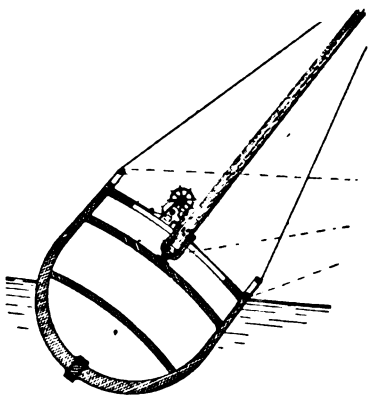
Claim.—1. In a steering apparatus, an upright support, a tiller-shaft passing vertically therethrough and provided at its upper end with a beveled gear wheel, a tubular shaft mounted horizontally thereover and provided with a corresponding beveled gear wheel of less diameter than that on the tiller-shaft, a hand wheel connected with said tubular shaft, a rod passing longitudinally through said tubular shaft and movable therein, a locking disk connected with the tiller-shaft, and devices operated by said rod and operating in connection with said disk for locking the tiller-shaft against rotation. Five claims.

720,015. SHOAL-WATER INDICATOR. FERDINAND E. FORSTER, NEW YORK, N. Y.



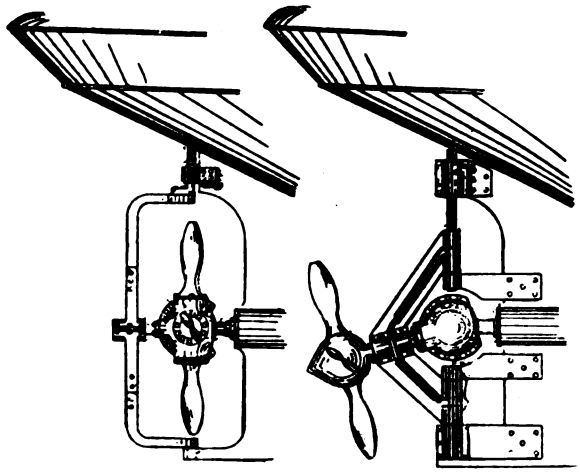
Claim.—1. In a shoal-water indicator, a sounder, adapted to be submerged and travel with the vessel, a sustaining wire attached to said sounder, and a resonator actuated by the vibrations of said wire and adapted to indicate audibly the contact of said sounder with the bottom. Ten claims.

720,074. AUTOMATICALLY LOWERING MAST. CARL SCHWANEBECK, GLUECKSTADT, GERMANY.



Claim.—1. The combination of the mast, the socket in which it is stepped, hinged to swing athwart the ship, the shrouds, the rollers in the bulwarks around which the shrouds are led, and the windlass to which the ends of said shrouds are connected in such a manner that while those on the windward side are paid off, those on the lee side are proportionately taken in. Five claims.

719,958. SCREW PROPELLER FOR THE PROPULSION AND STEERING OF SHIPS. JOHN SINCLAIR, BALMAIN, NEW SOUTH WALES, AUSTRALIA.



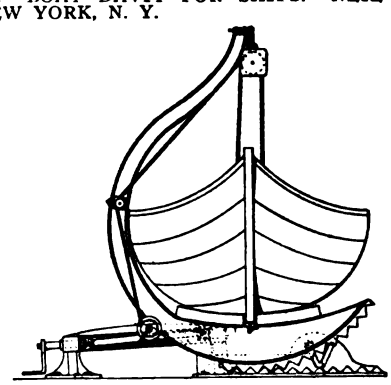
Claim.—1. A main or propeller shaft, a spherical hub on said main or propeller shaft, a divided sphere having a segmental opening embracing said hub, the said hub having two diametrically opposite driving pins and said divided sphere being slotted to receive said pins, both ends of slots being closed, and propeller blades mounted and balanced directly on said dividing sphere. Six claims.

720,076. ATTACHMENT FOR RANGE-FINDERS. ROBERT J. SHEEHY, NEW YORK, N. Y.

720,101. TORPEDO FOR SUBMARINE MINES. FRITZ BAUDUIN, LA HAYE, NETHERLANDS. Six claims.

720,508. ELECTRICAL SHIP'S-LOG APPARATUS. THOMAS F. WALKER AND THOMAS S. WALKER, BIRMINGHAM, ENGLAND. Two claims.

720,274. BOAT DAVIT FOR SHIPS. NEIL MURCHISON, NEW YORK, N. Y.



Claim.—1. A device for the purpose specified, comprising the toothed tracks, the connected davits having convex, toothed bases mounted on the said tracks, the top beam of the davits, the chocks mounted on the convex bases of the davits, tackles for suspending the boat from the top beam, and means for rocking the davits and the chocks on the tracks. Four claims.

Six Months' Shipbuilding Returns.—The Bureau of Navigation reports 627 sail and steam vessels, of 171,599 gross tons, built in the United States and officially numbered during the six months ended December 31, 1902.

Lehigh University.—A course in marine engineering is given by the Department of Mechanical Engineering at Lehigh University, South Bethlehem, Pa. In all twelve courses of instruction are offered. The list of graduates within the last thirty-seven years numbers 1,248. Several prize scholarships are offered, and provision is made for worthy and needy students whereby they may postpone payment of tuition until after graduation.

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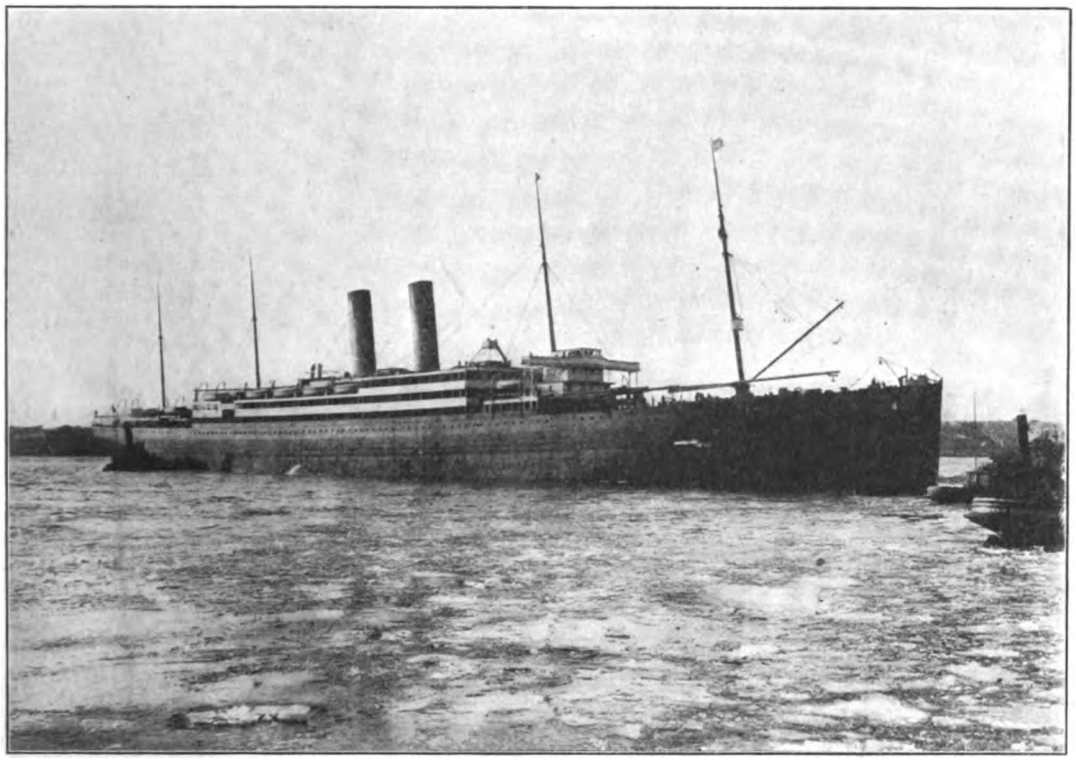
Marine Engineering

Vol. 8. NEW YORK, APRIL, 1903. No. 4.

NEW WHITE STAR LINE STEAMSHIP CEDRIC.

The appearance of a new large ship in the transatlantic trade is becoming of such ordinary occurrence that the *Cedric's* introduction to our harbor was looked upon with only passing interest by the general public. However, to the shipbuilder and those interested in allied trades this great ship possesses many interesting features. The steamship *Celtic*, of the White Star Line, has already been described in these pages, and her sister ship, the *Cedric*, the subject of this article, has the same external dimensions as the *Celtic*, but, by reason of structural differences, to provide increased passenger accommodations, the gross tonnage of this new ship is slightly increased.



WHITE STAR LINE STEAMSHIP CEDRIC, THE LARGEST SHIP AFLOAT.

The *Cedric* is 700 feet in length, 75 feet breadth, 49 feet 4 inches deep, with a gross tonnage of 21,000 tons and displacement of 38,200. Her general external appearance is shown in the engraving on this page. She has four masts and two funnels and a flush weather deck from stem to stern. It is on this deck that the several superstructures are erected. The most striking feature of the hull construction is the doubling of the shell plating for three strakes over practically the entire length from stem to stern. She has a complete double bottom, built on the cellular system, and above this are five complete steel decks, which we will call orlop, lower, main, upper, and spar decks. The shell plating is laid in in-and-out strakes below the main deck, and lapped at the ends; from the main deck up it is laid flush, and the three strakes between the main and upper decks are doubled.

There are nine hatches, eight of which are for cargo, besides the engine and boiler-room hatches, and these are served by from two to three winches each. The windlass is placed in the forecastle for controlling the two stockless anchors, and four capstan heads lead to the deck above. The foremast is stepped between hatches Nos. 1 and 2; the mainmast aft of the officers' bridge house, forward of hatch No. 4; the mizzen is placed at the forward end of the second cabin deck house, aft of hatch No. 5; and the spanker, between hatches Nos. 7 and 8. A large capstan is placed at the stern. The cargo booms serving these hatches are mounted on mast platforms, as shown in the illustration on page 167 of the

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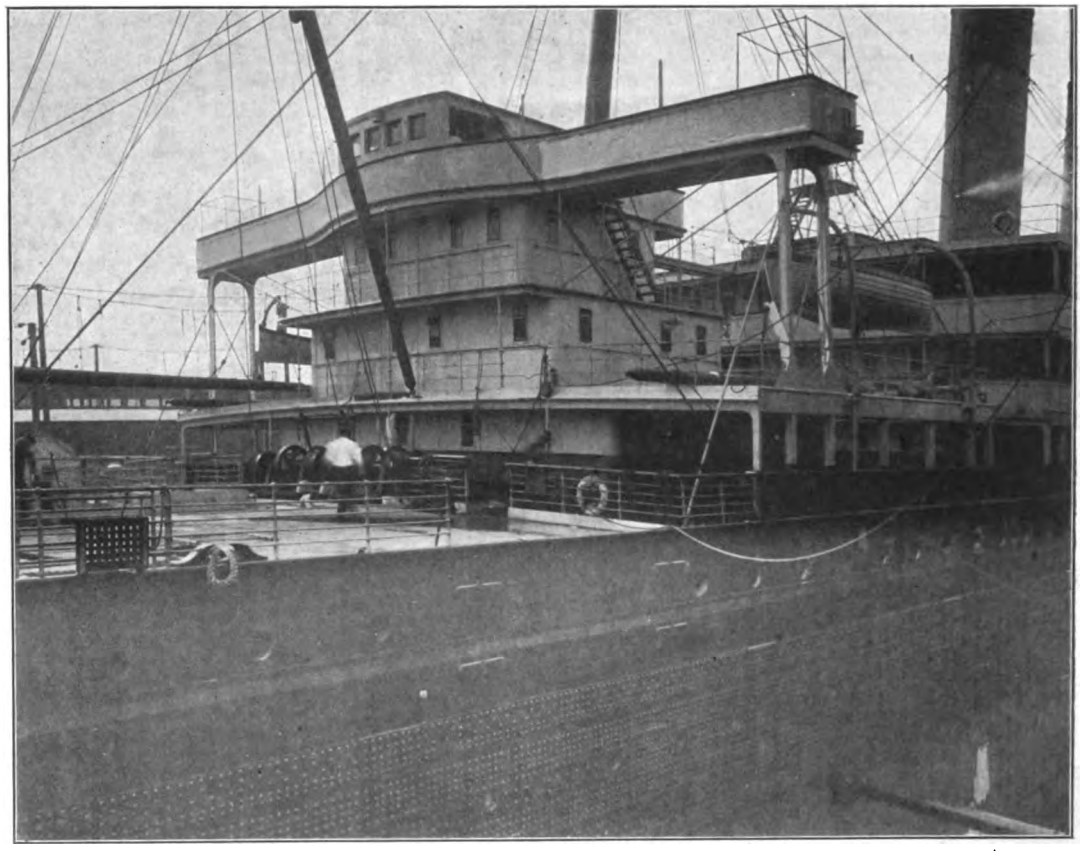
spar deck, looking forward. When at sea the booms are lowered in the rests, as shown in this engraving. The steam cargo winches each have four gipsy heads.

The particular feature of the deck houses is the officers' bridge house, just forward of the foremast. In this are located the navigating officers' quarters, the captain's rooms, and the chart room. Thus the deck department is separated from the passengers' cabins, and there is no possibility of interference in the navigation of the ship by the passengers. A flying bridge extends from the captain's bridge to the top deck of the main deck house, on which is mounted, on a high platform, the ship's compass. This can be seen in the illustration. The main house has three decks, all of which are devoted to first-cabin passenger accommodations. The after deck house is for the second cabin, and two smaller houses for the steerage.

In the matter of boat equipment the *Cedric* is probably the first liner to abandon the old-fashioned bent-arm davit in favor of an improved mechanical and infinitely more efficient system for handling the boats, the owners having fitted the ship with the Welin quadrant gear. The davit was illustrated on page 665, December issue. There are eight 30-foot lifeboats swung from this type of davit, and when the ship is at sea the boats are chocked along the edge of the deck to save promenade space. Before entering the harbor the chocks are removed and the boats swung completely inboard. The davit arms are of cast steel, revolved on a quadrant with a gear foot which sets in a track. The swinging quadrant is operated by a screw made of gun-metal, and the guide rods are sheathed with brass tubing to prevent corrosion. A special winch is provided for hoisting the boats from the water to the deck level, and two to four men suffice for swinging the boat inboard. The entire equipment has a smart and business-like appearance, and is a great step in advance over the old style of davit.

An exhaust system of ventilation is provided for the saloons by large fans placed on the boat deck. Air ducts lead from the domes and skylights, as shown in the illustration of the hurricane deck, to carry the exhausted air to the fans.



NAVIGATING BRIDGE HOUSE AND DECK VIEW, STEAMSHIP CEDRIC.

The *Cedric* will have accommodations for 350 saloon, 250 second-class, as well as about 2,000 third-class passengers, in addition to a crew of 335 men, 92 of whom will be in the engine room, making nearly 3,000 all told. The first cabins are arranged on main and upper decks and in the deck houses, as above stated. The first-class dining saloon is a handsome apartment, in gilt and white, situated on the upper deck, and extends the full width of the ship, with a seating capacity of 340 passengers. The furniture and general appointments are excellent, and there is more than the usual space between the tables. The library is a luxuriously-furnished room, and the smoking saloon is well appointed, the style being in keeping with similar rooms on other ships of this company. The state rooms and passageways are

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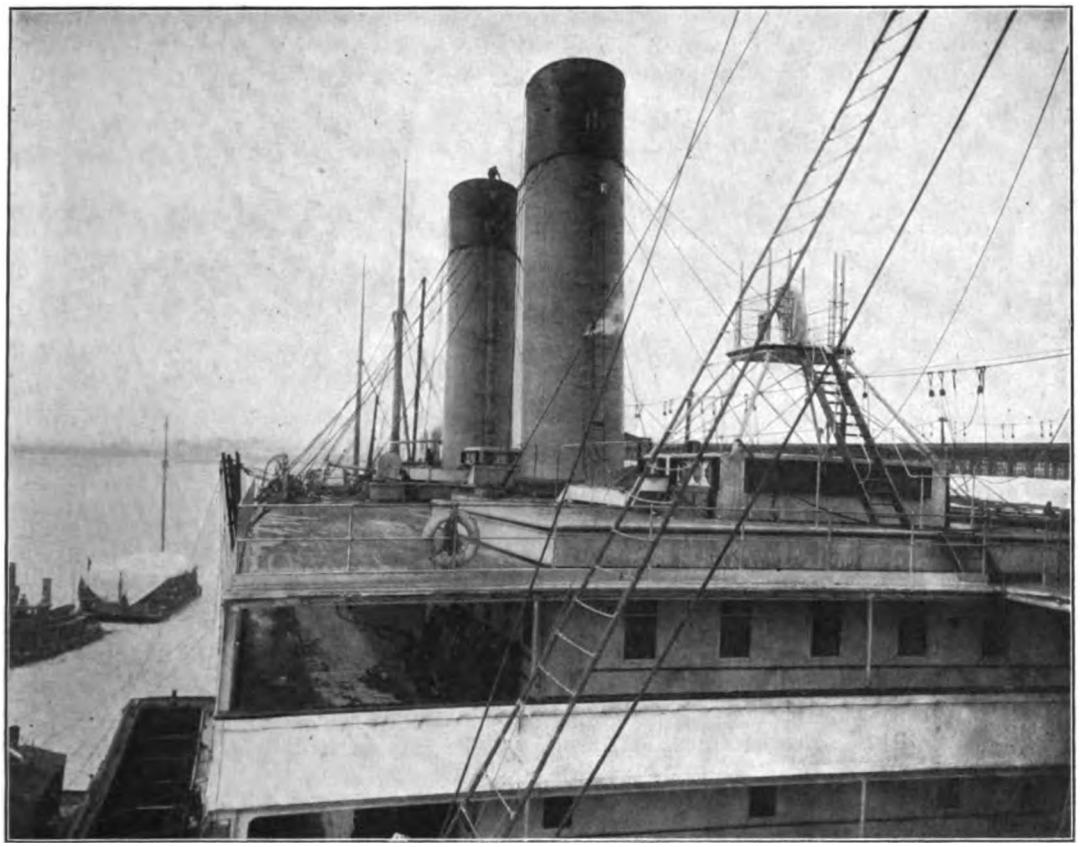
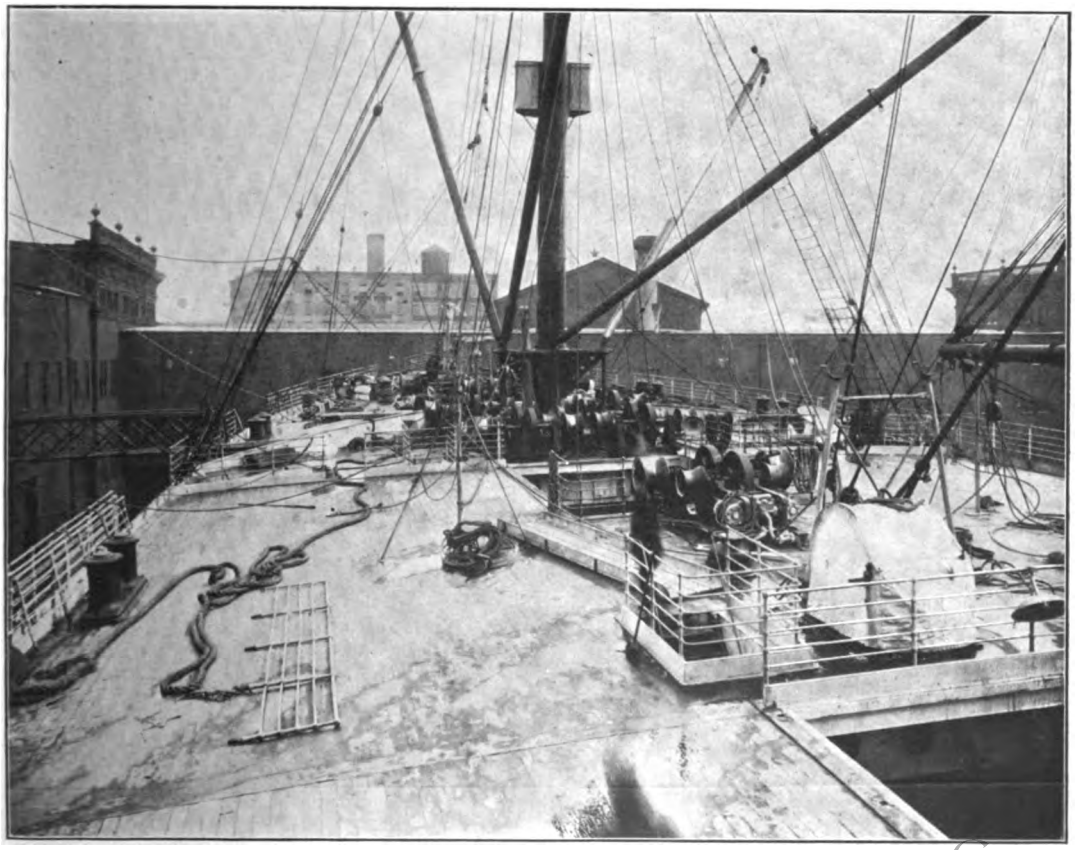


MIDSHIP DECK HOUSE, STEAMSHIP CEDRIC, LOOKING AFT.



FORECASTLE DECK, STEAMSHIP CEDRIC, SHOWING CARGO-HANDLING APPLIANCES.

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plainly finished in white paint and mahogany trimmings. One of the unique features is the placing in each room of an electric heater controlled by a switch alongside the bed. Large lavatories are provided, and the bath tubs installed are all of tin, not encased. The accommodations for the second-saloon passengers are on the upper deck and deck house, large and very well appointed for the second cabins. An unusually large number of third-class passengers can be carried aft, some in two, four, and six-berth rooms, and the rest in open berths. The beds are furnished with good spring mattresses, and the ventilation is well taken care of.

There are separate galleys and pantries for each of the three classes of passengers. In the first- and second-class quarters the floors of the main entrances and stairways are laid with patent rubber flooring, which is not only decorative, but prevents slipping or noise.

MACHINERY.

As one descends to the engine room he is struck with the roomy appearance, as the engine hatch is very large indeed, and there is much space below around the two sets of four-cylinder quadruple-expansion engines. This is for tonnage reasons; that is to say, the Board of Trade allows 33 1-3 per cent. for machinery space, and whatever of this is not used is measured as cargo space. Therefore, to reduce the tonnage and thereby save port dues, etc., all of this allotted space is devoted to machinery.

A recess on the orlop deck contains the four direct-connected Allen generating sets with compound engines. Each is of 500 amperes capacity, and, with 245 revolutions, maintains a voltage of 100 volts. The thrust shafts are located directly below this platform. Each engine works from the inside. The cylinders are supported on four cast-iron columns front and back, of the box pattern, which are braced at the top by cast-iron beams. The arrangement of the cylinders is as follows: First is the high pressure; next is the first intermediate; then comes the low pressure, and the second intermediate is at the after end. The crank webs on end cylinders have counterbalances. The cylinders are arranged in pairs; the high and first intermediate work almost opposite each other, the third and fourth at about right angles with the first pair, and the angular distance between cranks is given on the data card below. The valves of the high and first intermediate are at the ends of the engine, and those of the second intermediate and low pressure are at the center, adjoining each other. The high and first intermediate each have one piston valve; the second intermediate, two piston valves; and the low pressure, a balanced slide valve. The receiver between the high and first interme-

Name—Cedric. Nationality—British. Type—Intermediate freight and passenger.
Launched—Aug. 21, 1902. Owner—White Star Line. Builder—Harland and Wolff.

Length over all	700 ft.
Breadth, extreme	75 "
Depth to weather deck	49 " 4 ins.
Load displacement	38,200 tons
Launching "	14,257 "
Deadweight carrying capacity	18,400 "
Gross registered tonnage	21,000 "
Engines, type	four-cylinder quadruple
Valves	piston, except on L. P.
Cylinder diam.	33, 47 1-2, 68 1-2, 96 ins.
Stroke	63 ins.
Arrangement	H. P., 2d I. P., L. P., 1st I. P.
Sequence, H. P., 62 deg. 1st I. P., 96 deg. 2d I. P., 166 deg L. P. 96 deg. H. P.	
Balance	Schlick-Tweedy system
Condenser	in engine casing, 2 153 tubes each
Cooling surface	9 000 sq. ft. each
Auxiliary condenser	1,160 sq. ft.
Rev. at sea	77.5
I. H. P. at sea	14 000
Thrust bearing	18 3-4 ins., 10 collars 29 1-2 ins. diam., 3 1-4 ins. thick 7 3-4 ins. between
Shafting diam.:	
Crank	19 1-4 ins.; pins, 20 ins. diam.
Line	by 19 1-2 ins.
Tail	18 3 4 ins.
	19 1-2 ins., covered by 3 liners, 7 ft

Name—Cedric. Nationality—British. Type—Intermediate freight and passenger.
Launched—Aug. 21, 1902. Owner—White Star Line. Builder—Harland and Wolff.

Propellers, hubs	cast steel
Blades	bronze
No. of blades	three
Diameter	20 ft.
Pitch	24 ft. 6 ins.
Developed area	99 sq. ft.
Boilers	eight double end Scotch
Diameter	15 ft. 6 ins.
Length	19 " 6 "
Plates, shell	1 9 32 ins.
Furnaces, number of	six each
Diameter, mean inside	3 ft 8 ins.
Steam pressure	210 lbs.
Draft	natural
H. S.	41,680 sq. ft.
G. S.	1,008 " "
H. S. ÷ I. H. P.	2 98
I. H. P. + G. S.	13 9
H. S. ÷ G. S.	41 35

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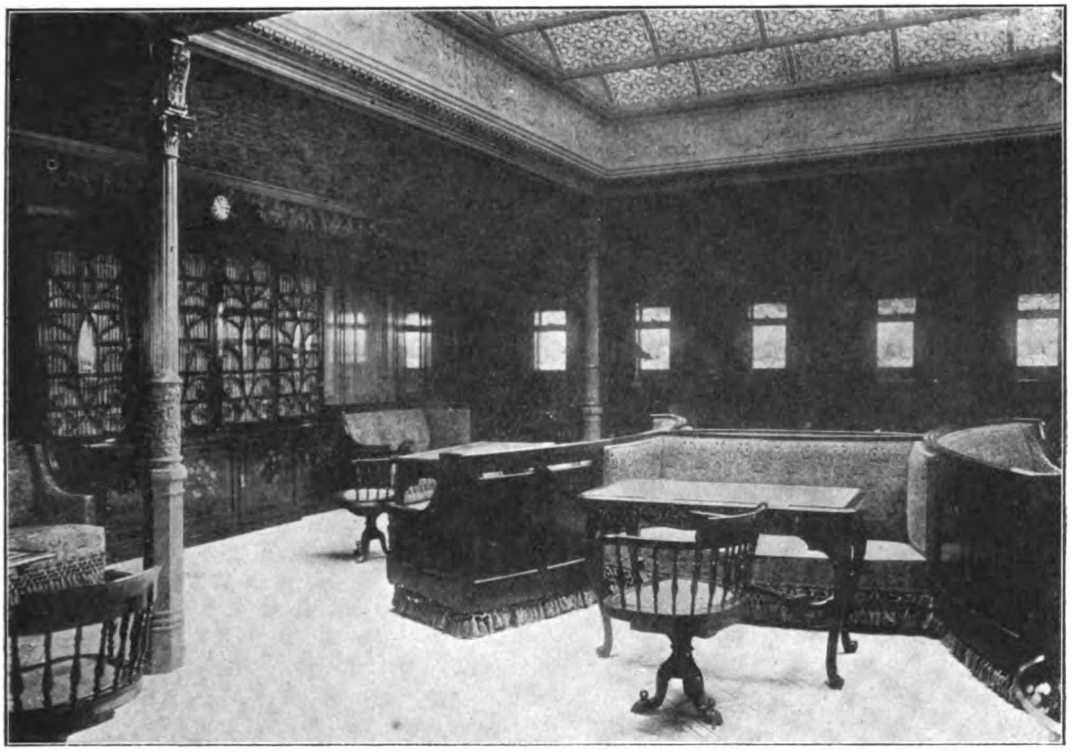

LIBRARY AND WRITING ROOM, FIRST CABIN.

SMOKING ROOM, FIRST CABIN, STEAMSHIP CEDRIC.

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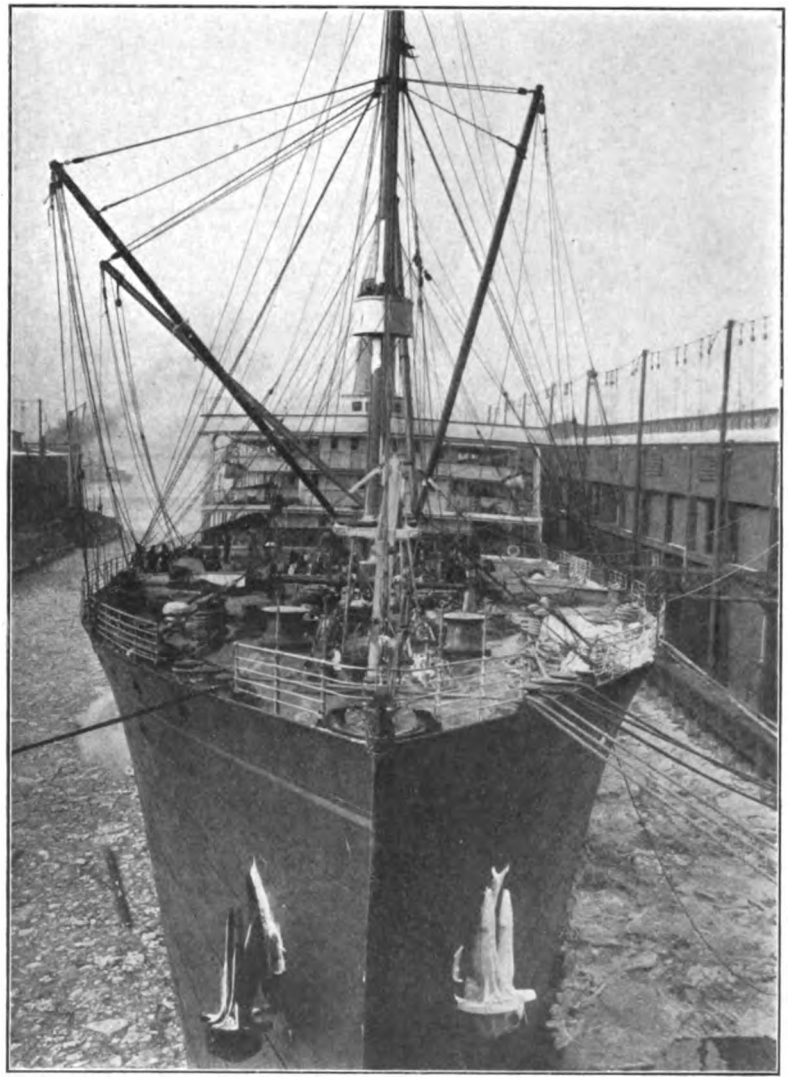
diate is placed on the outboard side of the engine. The condenser is built in the back framing of the two after cylinder columns, and the air pump is direct connected to the first intermediate. The shafting is solid and the crank shaft is in three lengths with eight main bearings. The distance between centers of cylinders is approximately 10 feet 6 inches, 17 feet 6 inches, 10 feet 6 inches. The thrust shaft is of the usual horseshoe type, with ten adjustable collars. The line shaft is in seven lengths.



BOW VIEW OF THE CEDRIC, AT HER WHARF, NEW YORK CITY.

and all couplings are fitted with nine tapered bolts. The connecting rods are of forged steel, with brass boxes at the top and bottom. The piston rods are attached to cast-steel crosshead blocks which are bolted to composition slides bearing on guides on front and back columns. The eccentric straps are of cast iron, and the rods are solid, with forged ends.

The reversing gear is of the usual Stephenson type, the reversing shaft being mounted on the inboard side of the engine, and is operated by a steam reversing piston. The turning engine is connected to No. 3 coupling. The feed pumps are placed at the forward end of the engine room, and are of the Weir pattern. There is the usual installation of bilge, water-ballast, circulating and sanitary pumps.

There are two separate water-tight boiler rooms, each one containing four double-end six-furnace Scotch boilers, each battery with two thwartship fire rooms. Shallow wing bunkers in the engine room supply coal from the bunkers above to the after stokehole. A thwartship bunker between the boiler rooms supplies the forward end of these boilers and the after end of the forward boilers, and another thwartship bunker supplies the forward hold. A recess in the forward boiler-room bulkhead leads to the refrigerating engine room, used for refrigerating the main 'tween-deck cargo space. There are no wing coal bunkers. One to the stokehole is fitted with two hydraulic ash ejectors, but in the other the ashes must be removed by buckets hoisted up the ventilator by a cable.

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THE THEORY OF LUBRICATION REDUCED TO PRACTICE.

BY J. K. NYE.

Oil is one of the necessary expenses of moving machinery, and in many cases its value would be a good interest on cost of the machinery it runs. It is safe to say that not one man in a thousand who deliberately squirts oil into a bearing really has any idea just why the bearing runs easier or cooler; sufficient for him that it does so, and lucky for him that an overload of oil seldom does harm. To these men friction means little or nothing, and a surface which is perfectly smooth to the eye is the best that can be made, and the little abrasive points which the microscope would show on such surfaces have no place in their minds, and consequently bear no reference to the use of the squirt can. Let any one of these men take a smooth file and press it ever so gently over a hard metal surface, it will do its work perfectly, tearing off little particles of the metal, but still leaving the surface smooth; but let them rub their hand over the surface of this metal and just the greasiness of the skin will so change its condition that the file will no longer bite, but will push over it, even with added pressure, without abrading it. This is one of the prettiest illustrations of lubrication that can be given, and carries with it every principle of friction and lubrication as fundamentally as old Watts' original machine carried with it the principles of the steam engine. The tiniest wearing surface of a watch pivot polished and finished to the highest degree and revolving in its jewel has on its surface as perfectly-developed abrasive points as the file, and from this up to the most gigantic bearing of the big marine engine the same condition exists.

Modern tools of precision have reduced this feature greatly, but even with this precision lubrication is a long way from perfection. If it were possible to standardize these imperfections a certain oil could be made the standard of certain sizes of bearings, but even with accurate tools our shops never turn out one surface just like another surface in its requirements of lubrication, either in the kind of oil or quantity to be used, and to ask the man in charge to exercise anything like the delicacy of perception necessary to cater to these microscopic variations in abrasiveness would be asking altogether too much of human nature. Thus in many cases manufacturers have found it necessary to so arrange the lubrication that it shall be automatic, and the prettiest practice of to-day is the case where excessive lubrication does no harm and where the waste is caught to be used over and over. In marine practice the severest conditions are found; the high-speed machinery, the close confines of the engine room, the high temperature, and the absolute necessity for long runs without stop, which allow no chance for examination, make anything like delicate lubrication out of the question.

The lubricants may be roughly classed under two heads: oils and greases.

The first including almost anything liquid made from mineral, animal, or vegetable.

Second, any compound of these which may be held solid or semi-solid at ordinary temperature.

Of course by far the greater proportion of oils are mineral products, known as hydrocarbons, produced from the earth. In marine practice no vegetable oil and very little animal oil is used, although some engineers still cling to the old method of pouring on lard oil; but it is safe to say that no animal oil is ever used on any steamship that could not be replaced to advantage by a mineral oil, provided a careful study of the situation were possible by the man in charge. Animal oil putrefies, or, in other words, oxidizes, under certain conditions, as every one knows, and those conditions could not be more perfect than those found in the engine room, particularly marine.

Oxidation or putrefaction means a formation of natural acid which will absolutely attack any piece of metal, especially if a minute quantity can be held in a correspondingly sized cavity which by reason of its motion has a tendency to heat; and if any engineer who reads this will stop and in his mind try to magnify the infinite number of little abrasive points and cavities which must exist, say, on a crank pin with its high speed and tendency to heat, he is then beginning the careful study of lubrication. He will then have at least a glimmering of the direful results which the formation of anything like an acid product would be to that microscopic pit, and, having conceived the damage to this tiny spot, he has but to multiply it by the tens of thousands of such little abrasive pits that must exist in even the finest turned and ground crank pin, to realize the ultimate result.

Mineral oils, being pure hydrocarbons and non-oxidizable, can never produce this result, although their very lack of oxygen gives them a certain evaporative power which requires a somewhat greater amount of oil. This very evaporative power, however, has a decided advantage in keeping the bearing cool, so that while perhaps a little more oil must be used to take up the evaporative loss, requiring a little more work for the man with the "squirt can," the results on the surface of the metal are far better. Engineers who care to, can go even further than to conceive of all these tiny abrasive points and pits, and by studying the phenomena of capillary attraction they will find themselves ultimately asking this question about these little abraded places which exist even in the finest bearing: Why do not these pits draw into themselves a little more oil than their actual volume? This is probably just what does take place. With a power infinitely weak the tendency is to separate the surfaces of the moving metal. While we realize that this separating capillary power *is* infinitely weak, let us again add our multiplying plan and multiply its tiny force by the millions of such little capillary pits that exist in the bearing. We shall find that the aggregate force which separates the metals will be enormous. Wherever two moving surfaces come together some of these little abrasive points are being constantly torn away, otherwise machinery would never wear out; but of course in some metals they are far more tenacious than in others. It has been found that two dissimilar metals, the one perhaps soft, the other hard, become far more serviceable in their wear and make easier lubrication, like a steel shafting running in a babbitted bearing, in which the hard abrasive points cut their own little paths in the softer metal. These little paths fill with the lubricating material, and, exercising their capillary forces, greatly lessen the friction, and by the very na-

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ture of the softer material carry off more rapidly the generated heat. With these facts in mind it becomes evident that the higher the speed at which one metal surface is running over another the thinner the lubricating material needs to be, both for its greater ability to enter the capillary passages and more rapidly its evaporating power to remove the generated heat. Therefore the gravity, viscosity, and fire test (the latter of which indicates its evaporating qualities) which may be used in any particular bearing must be left wholly to the judgment of the man in charge of such a bearing, and it is up to him to understand and choose for the situation.

So much for bearings; when it comes to the steam cylinder we have an altogether different and far more difficult phase of lubrication. The high temperature of the steam not only changes the nature of the oil, but adds greatly to the ease with which the abrasive points and pits change their nature. Steam itself changes the chemical constitution of the lubricating material, and in the case of compounded oil, which is so largely used at this day, the very viscosity itself becomes radically changed. Those parts containing oxygen may become semi-solids or even solids, which, filling the little microscopic pits of the metal, allow no chance for the thinner fluid to flow in and exercise its capillary force. While for a long time the surface about such a solid filled pit may become brilliantly smooth to the eye, the natural decomposition which will take place rapidly in a high temperature and the presence of watery vapor will gradually deepen and deepen its tiny hole until the inside walls actually crumble away, and in time destroy the fit between the piston rings and the walls of the cylinder. Here again the engineer has a wide field for study. The varying piston speed, the wide range of temperature by reason of steam pressure, and even the quality of the iron itself, bear more strongly than is generally supposed upon the system and quality of lubrication, and it is the writer's belief that by far the safest oil for the lubrication of the steam cylinder is an absolutely straight mineral oil. In many cases the steam itself, with its own fluid capacity for capillary operation, is a perfect lubricant, and the only requirement for a more viscous substance is the small portion required to fill a certain number of large or irregular cavities which may exist beyond the power of the water to fill.

We will return a moment to the subject of bearing. We all know that to turn and perhaps grind an exquisite fit would be far too expensive in most cases, so that many bearings are indeed so loose that, even without being sensibly so, there are large spaces between them and the shaft itself. In such cases the oil will flow away from it directly by gravity, and it becomes necessary to have some substance far more viscous and with a sort of glacial movement in order that the bearing be filled at all. This is the province of the greases. Such a bearing would not heat rapidly, and at the same time the grease holds sufficient capillary power to keep the shaft fairly well suspended. It would be obvious that such a lubricant would never do for a steam cylinder.

Another interesting scientific fact some engineers may do well to study is the varying property that different liquids have for resisting disruption, some vastly more than others. A very pretty illustration of this is the old trick of rubbing the edge of a wineglass with the wetted finger. Water has very little power of resisting disruption, consequently it forms little or no film upon the smooth glass edge of the wineglass, and the little abrasive points catch and let go as the finger is moved over them in such a rapid manner that a musical note is sounded; but the slightest particle of oiliness would instantly change the condition and the finger run over without resistance. This is because the oil gathering in infinitely minute drops fills the abrasions of the surface, and, resisting disruption, lifts the finger away from the glass itself. This illustrates one of the principles of lubrication.

Oil is sold largely by brands, and almost every engineer knows how utterly helpless he becomes when placed in the hands of an oil drummer with his sample of "Everlasting Cylinder Oil" or "Everlasting Machinery Oil." "The only brand on the market which will absolutely do its work perfectly."

It would not be difficult for any engineer, if he were so disposed, to get from a reputable manufacturer all the information he needed regarding gravity, viscosity, and fire test of every mineral oil. If he would in his mind's eye watch the operation of the little particles of oil as they move in the cylinder or bearing, he would in time get his perception delicate enough to choose, by just this gravity, viscosity, etc., alone, what was best suited to his class and quality of machinery, and, having once attained to that knowledge, no wily drummer could thereafter offer anything but just what he knew to be the best. If the practice were universal all brands would in time disappear from the market and the oil would be sold by the above-named terms strictly by its chemical constitution.

If a steamship leaving New York, taking a supply of oil of some well-known brand, should run short at a South American port, the engineer is utterly in the hands of some dealer on replenishing his supply; but, knowing the gravity, viscosity, fire test, and other standard requisites, he can always buy the same article in Rio Janeiro that he bought in New York. There is little probability that a brand of "Everlasting Machinery Oil" would be the same in Rio Janeiro as in New York, but if an engineer knew enough to distinguish a "23 gravity, 420 fire test, 414 viscosity oil," such as the Standard Oil Company sells the world over, he could duplicate it in any part of the world.

I name this particular oil as an example; the same is true of every grade of mineral oil, from a 300 fire test up to the heaviest cylinder oil.

There are a large number of chemical compounds sold in the market to-day by their percentage of useful qualities, and in most cases this is the cause: the evils of an inferior quality show immediately, and the minds of men have become so wary that they have learned to quickly and easily distinguish a proper and improper article for their use, although they have been obliged to study and make use of instruments to be able to make their determination. Unfortunately the evils of an improper oil are a long time in developing. The keenness of perception which a man must cultivate to be able to distinguish the exact quality of an oil against the eloquence of the drummer can only be acquired by close observation and the use of instruments.

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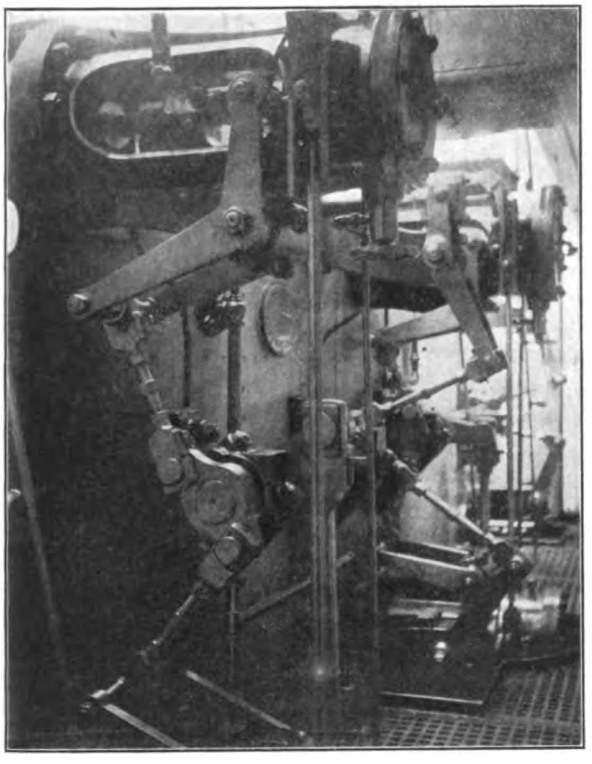
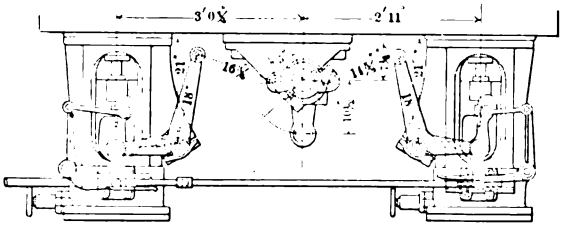
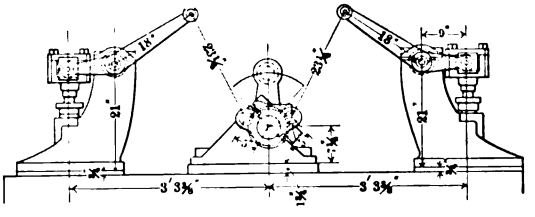
To be sure, there are many engineers who look upon the purchase of their oil as a legitimate perquisite, and this glowing eloquence of the drummer makes anything like the real commercial value of an oil hard to determine; but, given an honest, thoughtful engineer who is willing to study and learn the correct lubricating qualities of any oil for his particular use, it will be easy for him to determine the proper price for an oil, based upon the refinery price and its distance from point of production.



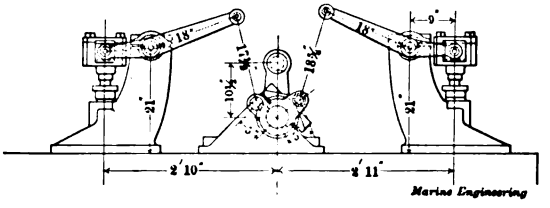
VIEW OF VALVE GEAR ON A MARINE ENGINE.



LOW PRESSURE CYLINDER STEAM GEAR



HIGH PRESSURE CYLINDER EXHAUST GEAR



LOW PRESSURE CYLINDER EXHAUST GEAR

DETAILS OF VALVE GEAR.

A MARINE ENGINE WITH CORLISS VALVE MECHANISM.

BY WILLIAM H. CRAWFORD, JR.

While we would naturally suppose that the highest type of marine engine development is to be found in the new ships that are being turned out almost weekly from the shipyards at home and abroad, there is at least one marine engine, of considerable age, that should not be overlooked; it is the compound engine built and placed in the steamer *City of Puebla* by the Wm. Cramp and Sons' Ship and Engine Building Company, of Philadelphia. Although it has since passed into apparent obscurity, the record of its performance is well worth investigation. The *City of Puebla* is now running in the service of the Pacific Coast Steamship Company between San Francisco and Seattle, by way of Victoria, B. C., touching also at various Puget sound ports. Prior to her appearance on the Pacific coast some years ago, this steamer was engaged in the New York-Havana service, where she was put into commission in the year 1882. After over twenty-one years of continuous running, with less than the average number of layups for this length of time, the engines in the *City of Puebla* are to-day able to hold their own with the best modern triple-expansion engine that has come to our notice, even as regards economy.

While the ship was building at the Cramp shipyard the design of her engines, a peculiar combination of gridiron valves with dashpots, and Corliss actuating mechanism, was worked out and patented by Messrs. R. W. Peck, James Younger, and Christian Hoehle. The engine has cylinders 43 inches in diameter high pressure and 86 inches low pressure, by 60 inches stroke, developing 3,571 H. P. at a maximum boiler pressure of 100 pounds. (See indicator cards marked *A* and *B*.)

The air, feed, circulating, and bilge pumps are independent, working from an auxiliary line of shafting mounted on the main engine frame, as will be seen by reference to drawing of engine shown herewith, and are driven by two vertical engines with steam cylinders 18 inches diameter by 24 inches stroke. Pump cylinders are all 5 1-4 inches diameter by 24 inches stroke.

By referring to the accompanying photograph of the valve rigging and dashpot arrangement on the main engines we can get a good idea of the unusual appearance presented in this engine room, which is probably one of the most interesting to be seen afloat to-day.

All valve setting and adjustments must be made while the engine is in motion; and, with proper care, almost perfect indicator cards can be obtained. The record for economy was made some time ago when A. H. Kress was chief engineer, the engine developing one horse power per hour on 1 3-4 pounds of coal.

At a speed of from 70 to 71 turns per minute this engine will drive the ship 14 knots per hour, and the maximum number of revolutions that has ever been

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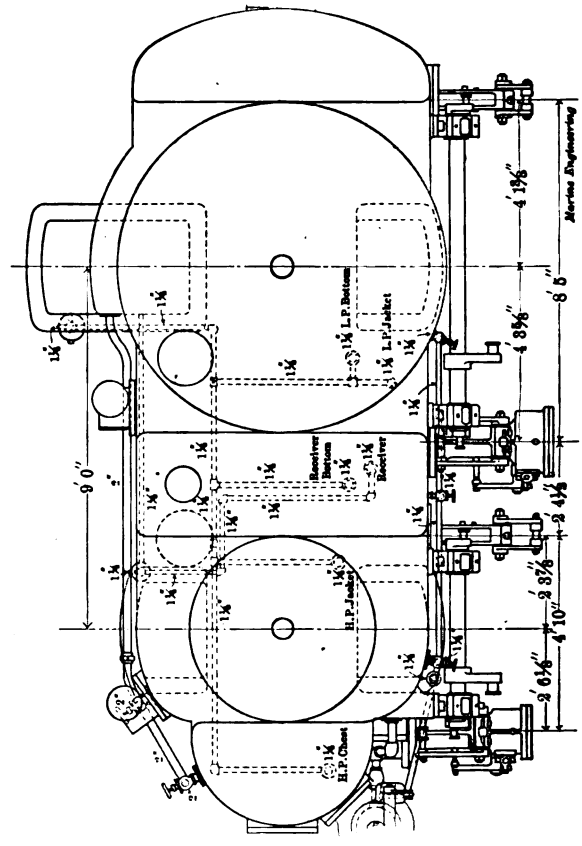
attained, as far as record goes, is 82 per minute, which gives a piston speed of 820 feet. Considering the size of this engine and its complication of parts, such a speed is quite remarkable. By referring to indicator cards *A* and *B* it will be seen that the balance of power is very good, on this occasion the high-pressure and the low-pressure cylinders being balanced to within 41 horse power of each other. The high-pressure was developing 1,765 of the total of 3,571, and the low-pressure 1,806 horse power. It should be added, however, that this is not the best that has been accomplished in balancing this engine. At one time the two cylinders were worked up so close to each other that no figure showed in the third decimal place, which was to all intents and purposes a perfect balance.

The main steam pipe is 12 1-2 inches in diameter, with two 9-inch branches and one branch 6 inches in diameter. One reason why such excellent results are attainable is because of the small steam clearances at both top and bottom positions. There are, as will be seen, two steam and two exhaust valves to each cylinder, making a total of eight valves. Careful adjustment is always required, as a difference of 1-32 inch on the high-pressure steam valve (and there are about 14 joints and connections from the main shaft to the valve stem in each case) will make a very appreciable difference in the steam consumption. This is easily understood by referring to sketch of the high-pressure valve and its seat. Here are eight openings about 15 inches wide; thus a travel of 1-32 inch would correspond to an opening of almost 4 square inches.

It is evident that a man must live right with this engine in order to get anything out of it, and eternal vigilance is the price of success in this case, if nowhere else. So far there have been but five men who have handled this engine in all the twenty-one years of service: Messrs. Bloxome, A. H. Kress, P. L. Plaskett, Frederick Nixon, and Thomas W. Spencer, in the order given. The indicator card is an indispensable ally.

On one occasion—to be accurate, August 9, 1902, at 6.15 P.M.—while the chief was sitting in his room, he heard the relief valve on the low-pressure receiver let go. This valve was set to blow off at 12 pounds, and, knowing that something unusual had happened, he got to the throttle as quickly as possible and closed it down, almost shut. The engine continued to turn over and he took an indicator card from the high-pressure cylinder, with the result as shown on card carked *C*. This gave evidence of a break in either the high-pressure steam or exhaust valve, which would allow steam at boiler pressure to blow through to the low-pressure receiver. On stopping the engine and investigating, it was found that the high-pressure exhaust valve and valve seat on bottom end were carried away, breaking, as shown by sketch. After clearing up the wreckage and disconnecting that valve stem, also disconnecting and closing the steam valve on the same end of the high-pressure cylinder, the engine was started up again, taking steam on the top end of the high-pressure cylinder only. The by-pass to the low-pressure receiver was opened just enough to make up for loss of steam, and the engine started again, after a delay of but 1 hour and 33 minutes. With cut-off at 26 inches, 100 pounds of steam on boilers, and engine making 61 revolutions per minute, the ship logged 12 knots per hour, the high-pressure cylinder, with the one end only, developing 777 horse power. In this condition the boat was able to continue on her voyage, making the regular run, calling at five ports, and handling almost as well as though nothing had happened. There are recorded



but two previous breaks of this character, one when the low-pressure exhaust valves were broken, and the other when one of the high-pressure steam valves broke. Aside from such minor troubles the twenty-one years of service of this engine is a record cleaner than it is usual to find where a ship has been driven so hard and so continuously.

It is a fact worthy of note that *no radical changes have been made* in the engines in this ship, regardless of their originality and the bold manner in which the designers laid aside all precedent. In fact, the most important change has been in the construction of the cutter bars. It is to be assumed that these will wear considerably and must be replaced from time to time. Originally they were simply made of blocks of steel tap-bolted down to the valve-stem crosshead. Now, by a gradual process of evolution, they are made to be the facing for a yoke, which is in turn fastened over the place where the original cutter blocks were located. In this manner it is possible to change the cutters without stopping the engine. The wearing face of the present cutters is 11-16 inch by 3 15-16 inches, and they are made of crescent steel.

It would seem as though this escapement feature of the valve motion with attendant wear on cutters would

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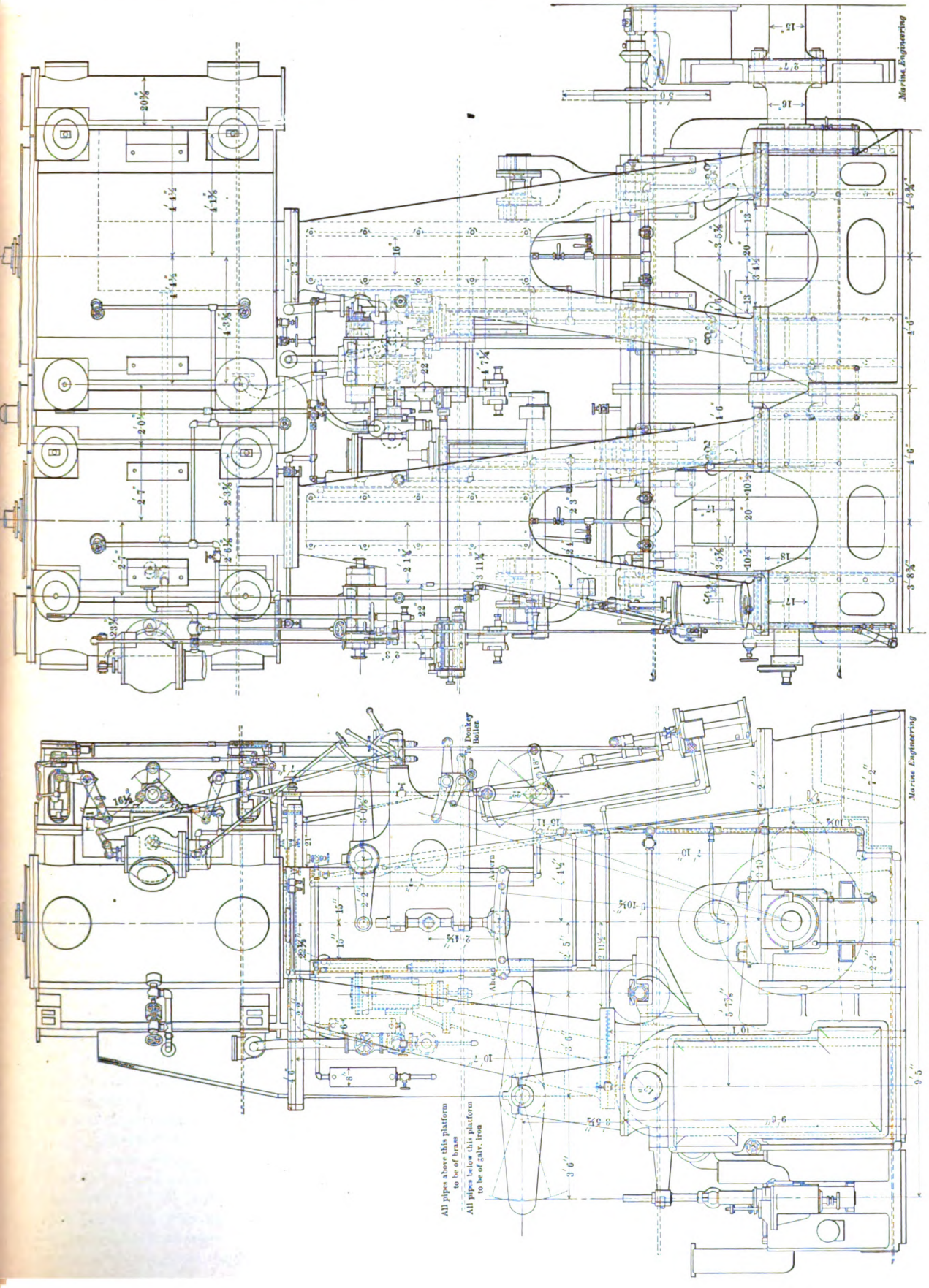

COMPOUND ENGINE WITH CORLISS VALVE GEAR ON STEAMSHIP CITY OF PUEBLA, BUILT BY THE WILLIAM CRAMP AND SONS' SHIP AND ENGINE BUILDING COMPANY.

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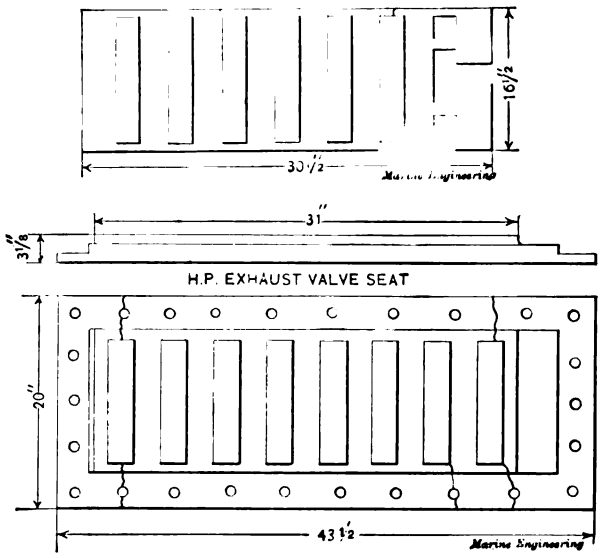
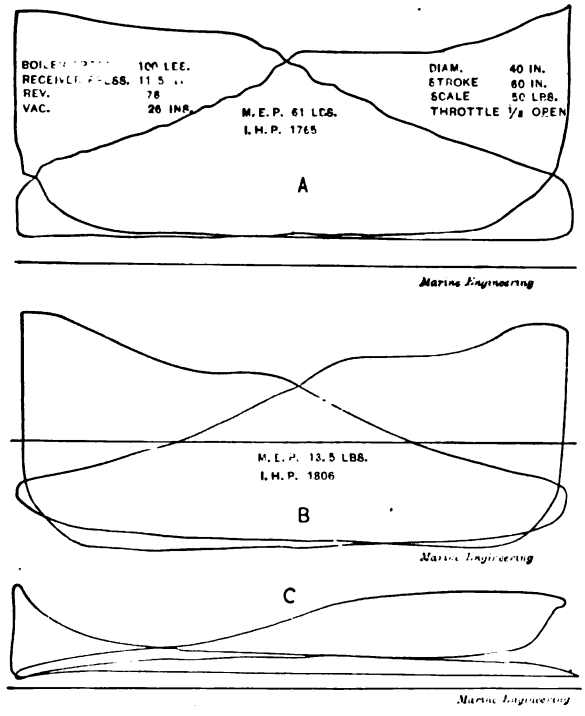
be a weak point in the engine, but it does not seem to interfere with making long-sustained runs. During the Spanish war the *City of Puebla* was running as a transport and on her last trip home from Manila she



GRIDIRON VALVE AND VALVE SEAT.

ran from Nagasaki, Japan, to San Francisco, over 5,000 miles, without stopping once for any cause whatever, making the run in a little over sixteen days. The



HIGH- AND LOW-PRESSURE AND FREAK CARDS.

City of Puebla as a record breaker was prominent in her day while in the New York-Havana service, and even now holds the record from Victoria, B. C., to San Francisco, having covered the distance in 48 hours and 26 minutes, or at the rate of 15.75 knots.

Name—City of Puebla.	**Nationality**—American.	**Type**—Coasting Steamer.	
Launched—1882.	**Builder**—Wm. Cramp and Sons.	**Owner**—Pacific Coast S. S. Company.	
Length over all	320 ft. 6 ins.	**Steam pressure at receiver**	11 1-2 lbs.
Beam	38 " 6 "	**Vacuum**	26 ins.
Depth	26 " 3 "	**Mean effective pressure, high**	61 lbs.
Load draft	20 " 6 "	" " **low**	13.5 "
Corresponding displacement	4,422 tons	**Propeller**, diam. 16 ft.; pitch, 23 ft.	
Deadweight carrying capacity	2,500 "	**Boilers**, number of	four single-end Scotch
Engines, type	compound	**Diameter**	15 ft.
Cylinder diam.	43 and 86 ins.	**Length**	12 " 9 ins.
Stroke	60 "	**Furnaces**, number of	four each
Valves....Corliss, with dashpots and gridiron valves		**Diameter**	41 ins.
Number of revolutions	76	**G. S., total**	320 sq. ft.
I. H. P.	3,571	**H. S., total**	9,040 " "
Steam pressure at engine	100 lbs.	**Feed pumps** 14, 8 1-4x10 in.; 9, 5 1-4x10 in.	
		Generator	30 K. W.

Department of Commerce.

By act of Congress a new department has been made in the administrative branch of the government—Department of Commerce and Labor, with Mr. George B. Cortelyou appointed secretary. The following branches of the Department of the Treasury have been transferred to the jurisdiction of this new department: Lighthouse Board, Lighthouse Establishment, Steamboat Inspection Service, Bureau of Navigation, U. S Shipping Commissioners, National Bureau of Standards, Coast and Geodetic Survey, the several immigration bureaus, and Bureau of Statistics. From the Department of the Interior, the Fish Commission and the office of Commissioner of Fish and Fisheries have been transferred to the above-mentioned new department. The Bureau of Foreign Commerce is transferred from the State Department and consolidated with the Bureau of Statistics, which was formerly in the Treasury Department. The two new bureaus formed in the Department of Commerce are those of Manufacture and Corporations, the first of which shall be to foster, promote, and develop the various manufacturing interests in the United States, and their markets for the same at home and abroad. It shall be the business of the secretary of the second-named bureau to make an investigation into the organization and the conduct of business of any corporation.

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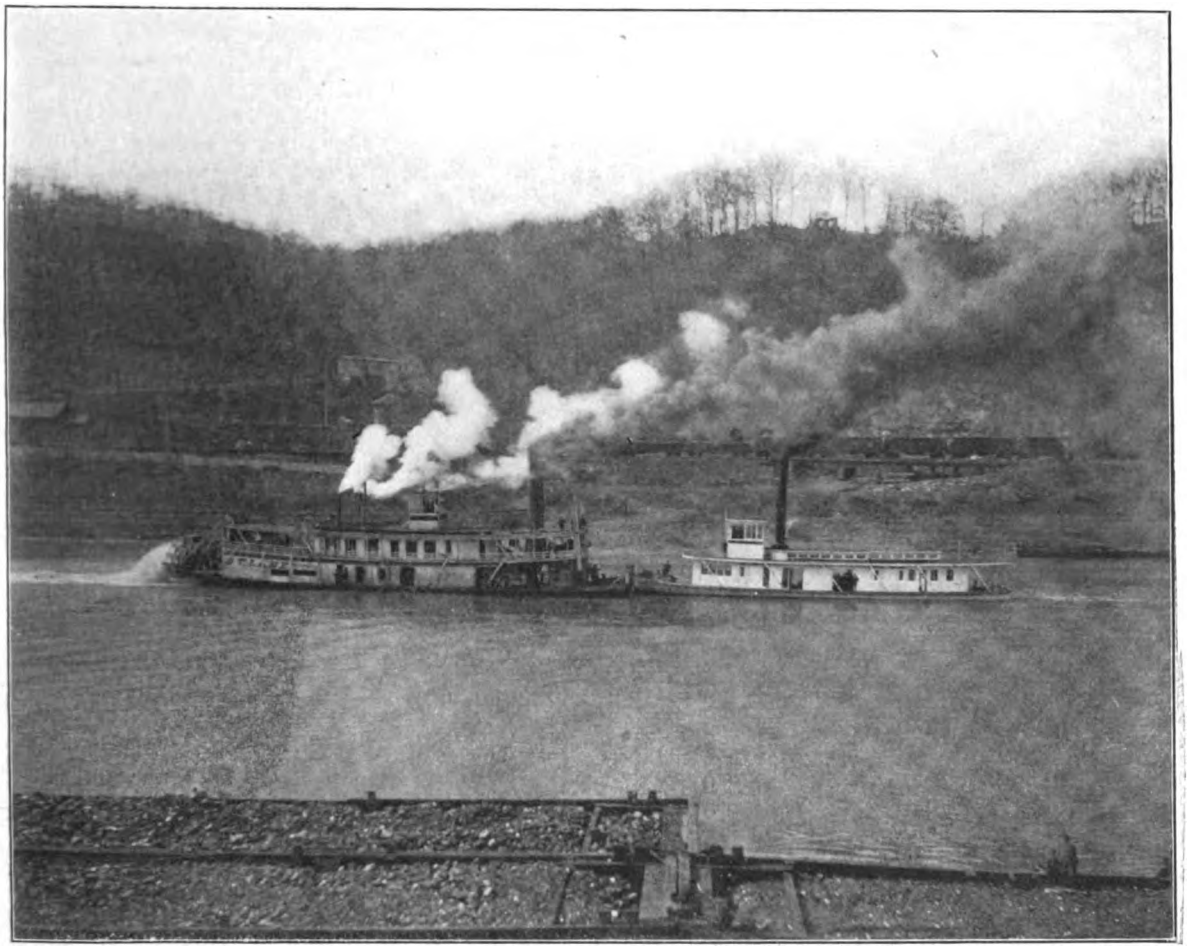

PUSHING TEST OF TWO KANAWHA RIVER STEAMBOATS; THE NEW TYPE AGAINST THE OLD.

Most Unique Test of River Steamboats.

There are many ways of making tests of steam vessels with steam-engine indicators, thermometers, water meters, pyrometers, patent logs, etc., but the most unique and practical test of towboats that has come to our notice is that of the stern-wheel steamer *D. T. Lane* and the twin-screw towboat *James Rumsey*, which was made in the Kanawha river, opposite Charleston, West Virginia, on March 7.

The Ward Engineering Company, Charleston, has just completed for the government a new type of towboat, christened the *James Rumsey*. The vessel is so entirely different from all other craft on the river that steam boat men felt confident that she would be a failure. The stern wheel has been the feature of Western river steamboats ever since steam was first used on these waters and very little change has been made. So, when the *Rumsey* appeared with a new type of engines and without the stern wheel, her ultimate failure was confidently predicted. She has two sets of quadruple-expansion engines with cylinders 7, 10, 14, and 20 inches in diameter by 12 inches stroke, and is supplied with steam by a Ward boiler.

The hull is 120 feet long, 22 feet beam, 4 feet 6 inches deep, and has a mean draft of 28 inches. She was found to give most excellent results in towing and swinging barges on the river, but her superiority to the old type was not recognized until the test above mentioned.

The *Lane* stopped on her way down the river with a large tow, moored the barges to the shore, and stood out in midstream to await her small antagonist. The latter came out to meet her and the bows of the two vessels were lashed together as shown in the engraving, as it had been previously decided to make a pushing and pulling contest.

In the first contest the *Lane* was on the upstream side and had the current and wind in her favor. The engines on both vessels were started at the same moment and run at full speed ahead. Gradually the larger boat pushed her small, impudent foe downstream a few hundred feet, but at a speed not as fast as the current. Then the relative position of the two contesting vessels was changed, the *Rumsey* being on the upstream side, and the test was repeated, this time the *Rumsey* driving her antagonist before her at a greater speed than she had herself been pushed downstream. It was, however, in the pulling contest that the smaller craft demonstrated her superiority in a still greater manner. When the engines of the two vessels were reversed, the *Rumsey* pulled the larger vessel at a fair speed.

It is seldom that we are treated to such a comparison of the old and the new as is presented in the accompany-

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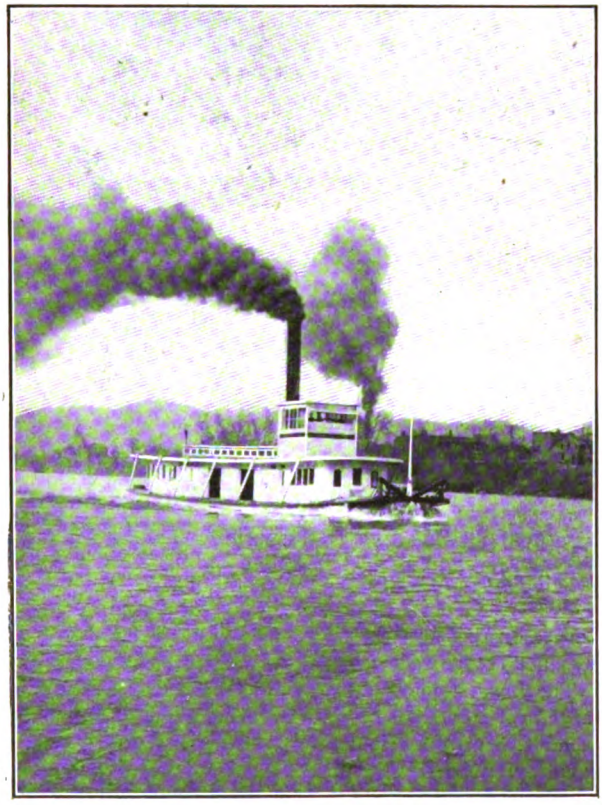
ing engraving; the old vessel with her non-condensing engines driving a ponderous stern wheel, with steam supplied by two long tubular boilers, and when running at full power the exhaust making a noise like a locomotive and the stern wheel piling up a column of water—in fact, the entire appearance being one of terrific strain. On the other hand is the little modern vessel with a twin-screw condensing engine, the steam supplied by a water tube boiler, and the only evidence of her running being a slight ripple of water at the stern, and the only noise that due to running high-speed engines.

It takes no prophet to foresee that the old type will be eventually displaced by the new as surely as the *Lane* was pushed away by the little *Rumsey*.



NEW TYPE OF RIVER STEAMBOAT.

New Ships Authorized by Congress.

Although the fifty-seventh Congress, which adjourned on March 4, failed to enact the ship subsidy bill, a measure that would undoubtedly have given a great impetus to shipbuilding in this country, it will be seen from the following that our national legislature was quite liberal in its provisions for new vessels for government use. Ships of all sizes were provided for, and naturally the Navy secured the lion's share. The following extracts are taken from the wording of the appropriation bills as finally passed by the Senate and House of Representatives and approved by the President:

"That for the purpose of further increasing the naval establishment of the United States, the President is hereby authorized to have constructed, by contract or in navy yards, as hereinafter provided, three first-class battleships carrying the heaviest armor and most powerful ordnance for vessels of their class upon a trial displacement of not more than 16,000 tons, and to have the highest practicable speed and great radius of action, and to cost, exclusive of armor and armament, not exceeding $4,212,000 each; two first-class battleships, carrying the heaviest armor and most powerful ordnance for vessels of their class, upon a trial displacement of not more than 13,000 tons, and to have the highest practicable speed and great radius of action, and to cost, exclusive of armor and armament, not exceeding $3,500,000 each; two steel ships, to be used in training landsmen and apprentices, to be propelled by sail, and to cost, exclusive of armament, not exceeding $370,000 each; one wooden brig, to be used for training landsmen and apprentices at stations, to be propelled by sail, and to cost, exclusive of armament, not exceeding $50,000.

"And the contract for the construction of each of said vessels shall be awarded by the Secretary of the Navy to the lowest best responsible bidder, having in view the best results and most expeditious delivery; and in the construction of all of said vessels the provisions of the act of August 3, 1886, entitled 'An act to increase the naval establishment,' as to materials for said vessels, their engines, boilers, and machinery, the contracts under which they are built, the notice of any proposals for the same, the plans, drawings, specifications therefor, and the method of executing said contracts, shall be observed and followed, and, subject to the provisions of this act, all said vessels shall be built in compliance with the terms of said act, and in all their parts shall be of domestic machinery; and the steel material shall be of domestic manufacture, and of the quality and characteristics best adapted to the various purposes for which it may be used, in accordance with specifications approved by the Secretary of the Navy; and not more than two of the five battleships provided for in this act shall be built by one contracting party; *Provided further,* That the Secretary of the Navy may build any or all of the vessels herein authorized in such navy yards as he may designate, and shall build any of the vessels herein authorized in such navy yards as he may designate, should it reasonably appear that the persons, firms, or corporations, or the agents thereof, bidding for the construction of any of said vessels, have entered into any combination, agreement, or understanding, the effect, object, or purpose of which is to deprive the government of fair, open, and unrestricted competition in letting contracts for construction of any of said vessels."

This large tonnage is the result of a compromise between the naval bills of the Senate and House of Representatives. The Senate bill called for four 13,000-ton ships and the House bill for two 16,000-ton battleships and one armored cruiser. The Navy Department favored the ships of larger tonnage. For a time it appeared that no compromise could be reached by the conferees of the two legislative bodies; but on the 4th of March the bill as above quoted was passed.

The 16,000-ton battleships will probably be similar to the *Connecticut* and *Louisiana*, now under construction at the Brooklyn Navy Yard and at Newport News. There are no American battleships, built or building, having a displacement of 13,000 tons; the nearest approach to this displacement is found in the vessels of the *Maine* class, which have each a displacement of 12,500 tons.

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The conferees in charge of the naval appropriation bill greatly enlarged the authority of the Secretary of the Navy in relation to the construction of war vessels in the navy yards, as will be seen by careful reading of the second clause above quoted. The broad authority of the Secretary to place $20,000,000 worth of new work in the navy yards will exert a powerful leverage in securing low bids from contractors.

The other vessels authorized are as follows:

$90,000 for relief light vessel for the third lighthouse district.

$90,000 for Five Fathom Bank light vessel, New York.

$90,000 for Cape Lookout Shoals light vessel, North Carolina.

$90,000 for Heald Bank light vessel, Texas.

$30,000 for relief light vessel for the ninth and eleventh lighthouse districts.

$75,000 for tender for St. Mary's river, Michigan.

$90,000 for Blunt's Reef light vessel, Pacific ocean off Cape Mendocino, California.

$20,000 for completion of revenue cutter for service at Philadelphia. (Original appropriation $50,000.)

$200,000 for a revenue cutter for the coast of Maine.

$45,000 for the purchase or construction of a steam tug in use in New York harbor in the prevention of obstructive and injurious deposits therein.

$2,000 for two launches for use of the fish-cultural stations at Gloucester, Mass., and Battery Island, Md.

$110,000 for the construction or purchase of a steel twin-screw ferryboat for Ellis Island.

$110,000 for a new steamer for the Coast and Geodetic Survey.

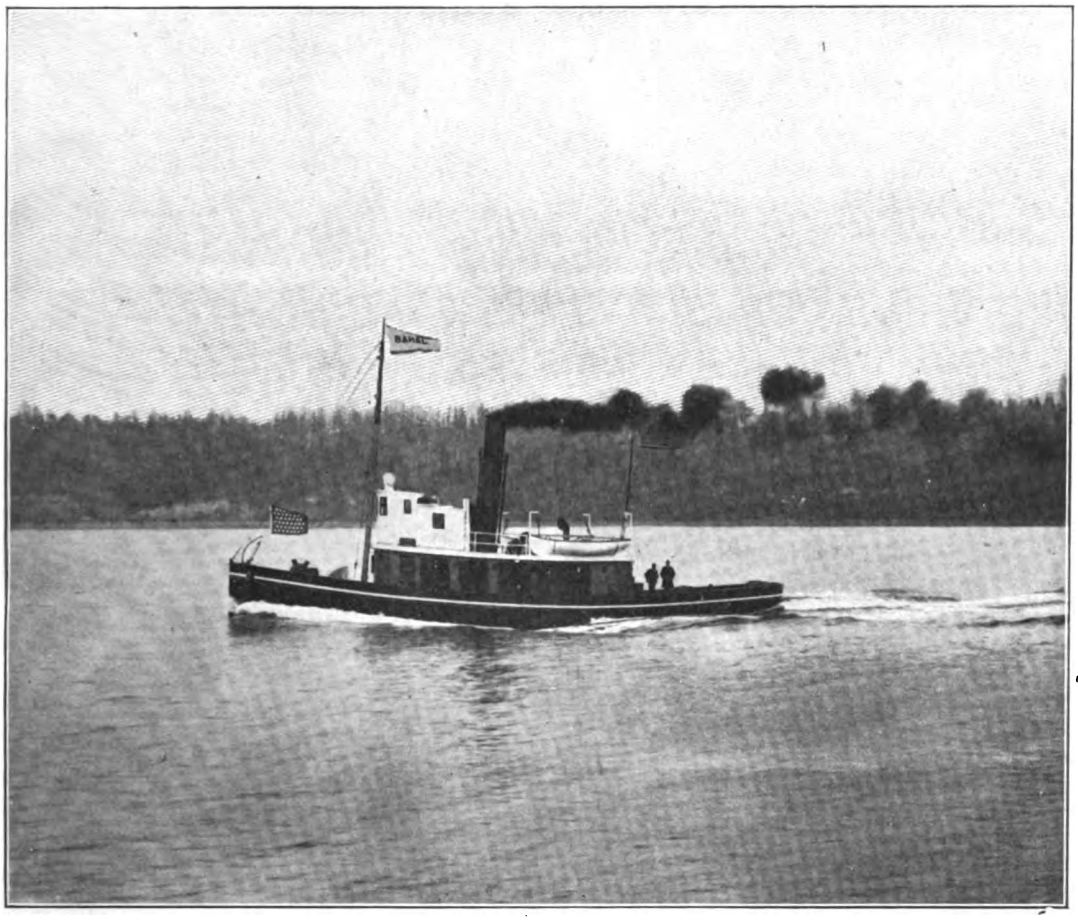
It will thus be seen that 22 new vessels of various sizes and types have been authorized at an aggregate cost of $21,468,000.

In addition to the new vessels the following repairs were specifically authorized:

$10,000 for rebuilding the Coast Survey steamer *Cosmos*.

$28,000 for repairs to the Fish Commission steamer *Albatross*, including electric-light plant and a new steam cutter.

For overhauling and repairing tug *Lamont*, $5,000.



NEW STEEL TOWBOAT BAHAL, BUILT BY MORAN BROTHERS COMPANY, SEATTLE, WASH.

Two New Towboats.

Two steel towboats have recently been completed at the works of Moran Brothers Company, Seattle, Wash., and one of these is shown in an engraving. The vessels are similar in all respects and the principal dimensions are: Length, 90 feet; breadth, 19 feet; depth, 11 feet 5 inches; and the tonnage about 130 tons. Each vessel is driven by a compound engine, the cylinders being 13 and 30 inches diameter with a stroke of 24 inches. A Scotch boiler 11 feet diameter and 11 feet long, working under a pressure of 160 pounds, supplies the steam.

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THE NAUTICAL PREPARATORY SCHOOL AND THE SHIP YOUNG AMERICA.

If one can imagine a well-equipped preparatory school, completely furnished dormitory, library, gymnasium, museum, laboratory, and an efficient corps of instructors, placed upon a big ship, and, with the pupils. taken round to the various countries of the world, he would form a very good idea of the Nautical Preparatory School of Providence, R. I. The purpose is to take young men and prepare them while afloat, visiting the principal countries of the world, for college or a business life. The students will be given a combination of theoretical schooling, practical training, and observation with world-wide travel on board a large steel full-rigged ship, instead of within the four walls of a building on shore. The course of study will comprise those usual in preparatory schools, the work being conducted by twenty-five professors and instructors. The number of pupils will be limited to two hundred and fifty.

Protracted cruises over many seas, visits to all lands, and contact with a great variety of people and customs, give unequaled opportunities for special studies, such as commerce and economics, science and natural history, that it would be impossible to obtain if ashore.

The *Young America*, the name to be given to the ship, will be a full-rigged steel sailing vessel with auxiliary steam power of modern type of construction. The vessel has the old sailing frigate divisions of spar deck, main or school deck, berth deck, orlop deck, and hold. A double bottom is fitted and the hull will be further subdivided into five water-tight compartments to insure safety and stability. All the comforts that are possible will be provided, and special attention has been paid to the question of safety devices and ventilation, pure water, and wholesome food. The ship will be commanded by a United States naval officer detailed for that service, and the other officers will, as far as practicable, be graduates of the United States Naval Academy. The course is also planned to prepare men for the Annapolis and West Point Academies.

The complete four years' course will include cruises to all of the principal countries in the world, and the calendar is so arranged that each cruise will be in a temperate climate and along the most approved routes for the avoidance of stormy weather. Students may be enrolled for from one to four years, while the term comprises nine months, from September to June. Opportunities will be given for going ashore and visiting the cities and points of interest along the route. Instruction will also be given in navigation and steam engineering. The school is planned on strictly naval lines, the cadets being formed into companies, and the companies divided into sections to be under the personal supervision of the professors. Cadet officers will be appointed after the first month on the basis of merit in studies and deportment; the first month they will be appointed by lot. The religious and physical training will be properly cared for, and the health of those on board will be under the charge of a regular physician. It is not the intention of those who have the Nautical Preparatory School under their direction that the course should train boys for sea service. Its object is to supplement a first-class preparatory education with world-wide travel and such knowledge of nautical matters as will aid them should they in after life be engaged in any enterprise in which ships and commerce are involved. The cadets are not to take part in the working of the ship, except for the purpose of drill, discipline, and gymnastic exercises.

Among the endorsers of this project are men throughout the country most prominent in all walks of life. The officers of the company are all of the United States Navy, and the Board of Directors and Visitors well-known throughout the country.

GENERAL ARRANGEMENT.

The arrangement has been carefully laid out and is shown in the accompanying deck plans. There are two deck houses on the spar deck, the forward one containing accommodations for the quartermaster, donkey boiler, drawing rooms, and a large music and recreation room, from which a stairway leads to the school deck below. A chart house and officers' companionway are in the after deck house. On the school deck, at the bow, are the crew's lavatory, store rooms, cadets' lavatory, and recreation space. On either side of the latter are the cadets' state rooms, professors' rooms, and a museum, and abaft it is the main berthing and messing space for the cadets. Further aft are the officers' rooms, with what might be called the ward room and a sick bay on the port side.

Descending to the berth deck one finds the forward end allotted to the crew and petty officers' rooms; following aft come the laundry, galleys, refrigerator, etc. Amidships is the remaining berth space for the cadets, and in the after end of the ship are placed the professors' quarters, with lavatories at the stern. On the orlop deck will be found a large cold-storage space after the chain locker, and then comes the auxiliary engine room, containing dynamos, refrigerating machinery, and pumps. The boilers are in the next water-tight compartment and also the evaporators. The coal is carried in two large bunkers amidships, and a water-tight alleyway leads from the boiler room through the coal bunkers on the midship line to the large space allotted to the servants, and it is through this alley that the steam pipe is led to the main engine, which is located at the stern. By this arrangement of machinery the ship will be on an even keel if the bunkers are full or empty. As the main engine is expected to be running only occasionally, the loss due on the condensation in the long steam pipe will not be great.

HULL CONSTRUCTION.

Now, turning our attention to the construction of the *Young America*, she is built under the U. S. Standard Registry of Shipping, and classed A1 twenty years. The vessel was designed and is under the supervision of Mr. William E. Winant, of Washington, D. C., and is being built by the Perth Amboy Shipbuilding Company, of Perth Amboy, N. J. The specifications call for a steel ship complete in every particular; the workmanship and material are of the highest class. The scantlings are given on the accompanying midship section, where it will be seen that she is to be of the flat-plate keel type, with vertical keel plate and keelsons. The stem and stern posts are of bar iron

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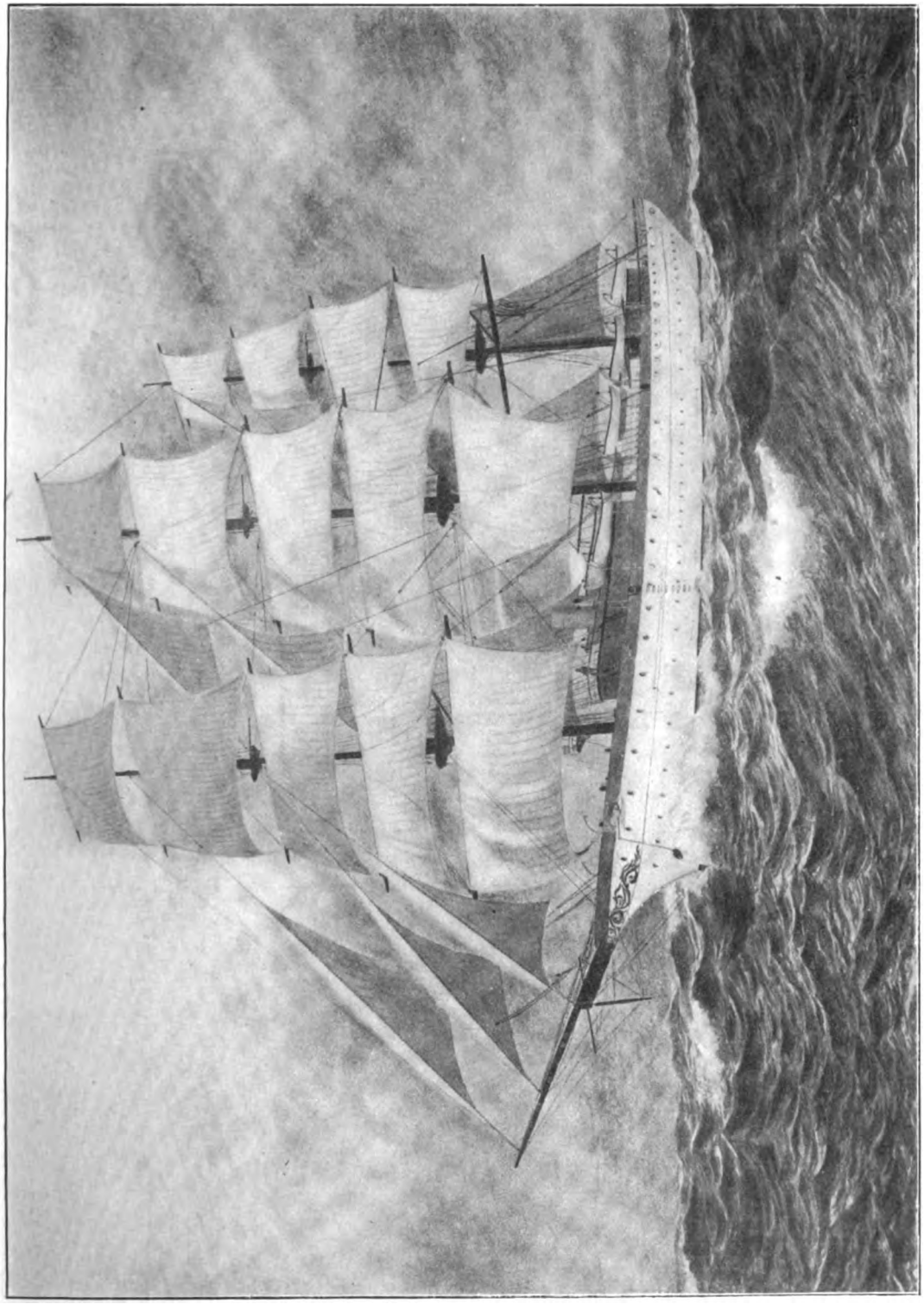

STEEL AUXILIARY FULL-RIGGED SHIP YOUNG AMERICA, BUILDING FOR THE NAUTICAL PREPARATORY SCHOOL OF PROVIDENCE, R. I.

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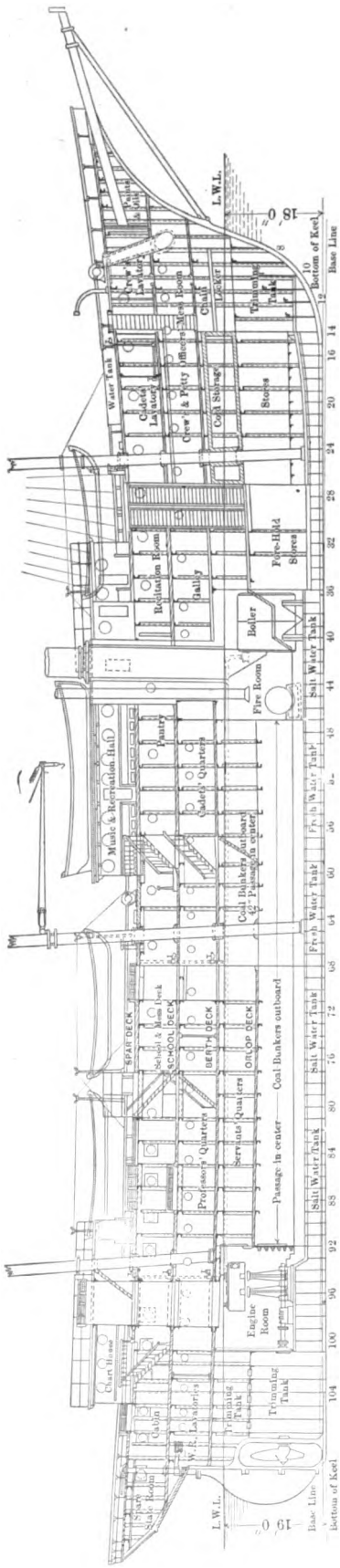

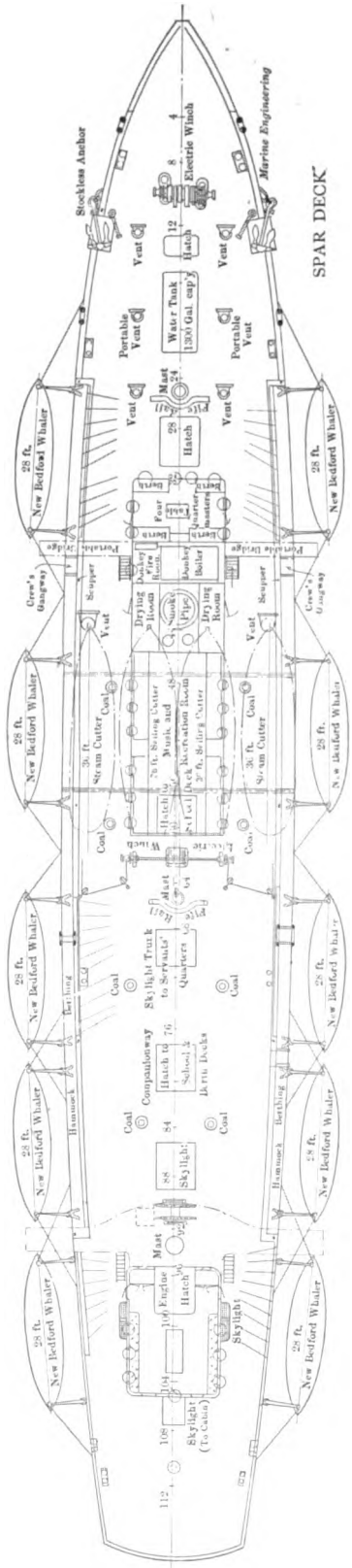

INBOARD PROFILE AND SPAR-DECK PLAN OF THE YOUNG AMERICA.

molded and sided, as shown. The rudder is also of wrought iron, of the double-plate type, filled with white pine, and payed with pitch and tar.

The frames are of dimensions shown in the section, spaced 26 inches centers; the stern tube is of wrought-iron pipe, properly connected with the stern post. The longitudinals, beams, plating, etc., are to be worked in according to the accompanying drawings of the dimensions given throughout. The bilge keels extend for one-half the length of the ship; the inner bottom is to extend across the ship and from frames 36 to 90. The transverse and longitudinal water-tight bulkheads will be worked as shown on the drawings.

Heavy foundations are to be placed in the engine and boiler rooms, as required by the rules. The deck houses are made of plate, laid in panels, with 12-inch finishing plate at top and 15-inch plate at bottom, extending all round the houses.

The bulwarks are formed by the outside plating extending forward, with a wood railing; mast partners are to be located on the decks where required. There is a trimming tank forward and another aft, fitted with necessary connections for drainage, and which will be controlled by valves operated from the deck. Potable water tanks, with a combined capacity of 3,000 gallons of water, are supplied and connected to the fresh-water piping throughout the ship and to the distillers. Stanchions are located wherever necessary to support heavy weights or to strengthen the structure of the ship.

Davits are fitted with the necessary tackle, etc., for stowing, securing, and letting go the anchors. The location of these davits, the boats, and the boat davits is shown on the spar deck plan. Two small galvanized wrought-iron portable hatch cranes are fitted so that they can be attached to any of the several hatches for lowering stores, etc.

The steering gear will be the hand-gear type, with a quadrant fitted on the forward side of rudder stock

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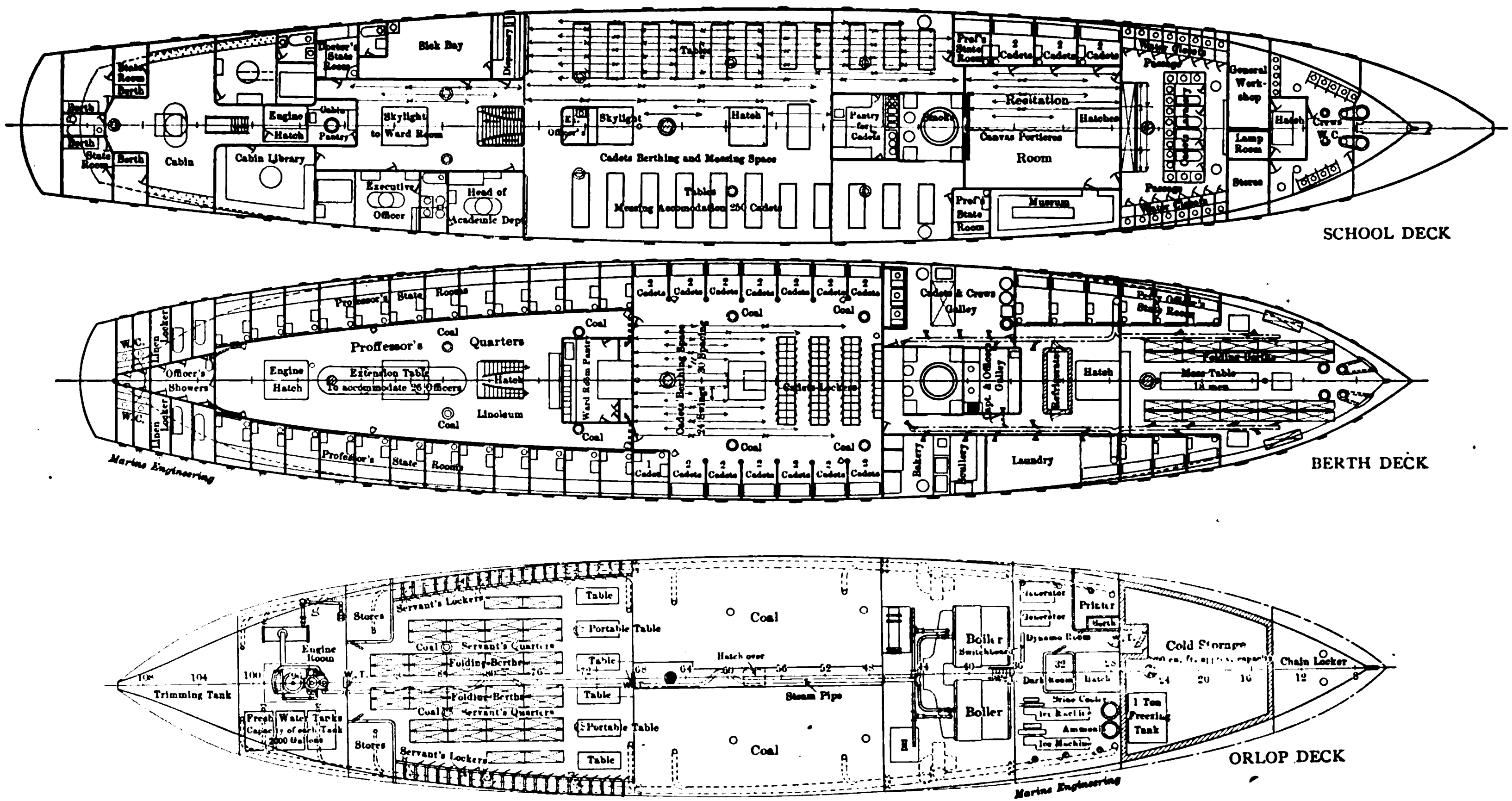

DECK PLAN OF THE NAUTICAL SCHOOLSHIP YOUNG AMERICA.

directly under the school deck beams aft, with steering rods led forward under the beams up to the pilot house to a drum with two hand cylinders; the rudder stock extends through the school deck and is fitted for taking a spare tiller when necessary. The coal scuttles are 18 inches diameter, and located as shown. Sluice valves, warping chocks, chain scuttles, hawse pipes, warping pipes are of cast iron, fitted where required.

Carpenter and Joiner Work.—The planks of the several decks are to be of thickness specified in midship section drawing and to be well-seasoned yellow pine. The spar and school decks will be calked, the berth and orlop decks being of tongued and grooved material, covered with linoleum where required. The state room berths throughout the vessel are to be of white pine, with sliding doors of the same material. Each state room will have one berth with lockers below and back, a bureau, wardrobe, and one chair. An electric windlass will be located in the forecastle with double gipsies. A winch, driven by an electric motor, will be located on the spar deck forward of the mainmast, to be used in lifting boats and manipulating the wire cables.

Rigging.—The rigging is of galvanized steel wire

rope, properly served where required, and of the following dimensions:

Lower rigging	3 3-4	ins.
Topmast rigging	2 1-4	"
Topmast backstays	4 1-2	"
Topgallant rigging	2	"
Royal deckstays	2 1-2	"
Royal stays and topmast stays	4	"
Jib stays	3	"
Topgallant stays	2 3-4	"
Royal stays	2	"

and all other wire to be the proper proportion as required.

The blocks will be of the inside machine strap pattern, with sheaves of ash and all ironwork galvanized. The sheaves will be of either smooth galvanized iron or lignum vitæ. Where heavy service is required the bushings will be metal lined. All running rigging is to be of best quality manila rope. All sizes above 2 3-4 inches are to be of four strand.

Masts and Spars.—The lower masts are to be single stick, of Oregon pine, the topmast and jibbooms of yellow pine. The royal yards and floating jibbooms, gaffs, and booms, of spruce, to be fitted with necessary masts and spar lap-welded ironwork. The foremast is 93 feet long and 28 inches in diameter at the partners, the mainmast about 98 feet long by 28 inches, and the mizzenmast 74 feet long by 20 inches. The fore and main topmasts and topgallant masts to be of the same size and to be interchangeable, of about the following dimensions:

Topmast, about 54 feet long by 18 inches diameter.

Topgallant mast, 57 feet long, 12 inches, single stick.

Mizzen topsail, 42 feet long by 12 inches.

Mizzen topgallant, including poles, 43 feet long by 8 inches.

The fore and main lower, double topsail, topgallant and royal yards, and topsail to be of the same length and diameter and to be interchangeable, of the following approximate dimensions:

Lower yard	97 ft.	by	22	ins.
Double topsail yard	91 "	"	20	"
Topsail yard	82 "	"	18	"
Topgallant yard	62 "	"	14	"
Royal yard	82 "	"	8	"

The mizzen spars are approximately:

Cross deck yard, 68 feet long by 16 inches diameter at centers.

Mizzen lower topsail, 64 feet long by 14 inches diameter at centers.

Mizzen topsail yard, 57 feet long by 12 inches diameter at centers.

Mizzen topgallant yard, 45 feet long by 10 inches diameter at centers.

Mizzen royal yard, 35 feet long by 7 1-2 inches diameter at centers.

The fore and main driver gaffs are to be 42 feet in length, including the arms, by 10 inches diameter, and the spanker gaff about 44 feet long, including the poles, with arms about 7 feet long. The bowsprit will be about 44 feet in length, with a topyard length of 19 feet, the greatest diameter being 28 inches. The single-stick jibboom will have a total length of 80 feet, including the poles, and will be 16 inches diameter. The other spars will include a dolphin striker, whisker booms, side-swinging booms, and boat booms.

Sails.—The sails and awnings are of canvas varying in weight from No. 1 to No. 7 for the royals and a No. 8 for boat awnings.

Boats.—The following boats will be supplied: Two 36-foot steam launches, two 36-foot sloop-rigged sailing cutters, ten 28-foot New Bedford whaleboats, two 14-foot wherries, two 12-foot square-ended punts, ten marine-built dories. The total capacity of these boats will be 474 persons, while the complement of the vessel is at 414.

Electric Plant.—The electric equipment will consist of one dynamo of 20 K. W. capacity and one of 10 K. W., directly driven by double-acting steam engines. Current is supplied to about 480 10 C. P. lamps located throughout the ship, and 6 receptacles will also be placed at convenient points for taking current for decorations.

Ice Plant.—A horizontal ammonia refrigerating machine is located in the forward hold, of one-ton capacity in twenty-four hours.

Plumbing and Piping.—The plumbing and drainage is laid out with great care and in the most sanitary pattern. The fresh-water tanks of the hold throughout the ship are piped up with a distiller and evaporator and to the galleys, etc. A 4-inch fire main is laid the entire

Name—Young America. **Nationality**—American. **Builder**—Perth Amboy Shipbuilding Co.
Type—Steam Frigate. **Launched**— **Owner**—Nautical Preparatory School.

Length over all	270 ft.
" on load-water line	236 "
Beam, molded	43 " 10 ins.
" extreme	44 "
Depth to spar-deck beam	33 " 4 "
Draft, forward	18 "
" aft	19 "
Displacement, corresponding	2,600 tons
Engines, type	compound
Cylinders, diameter	22 and 44 ins.
Stroke	24 "
Valves...piston 8 1-2 inches on high, and slide on low	
Thickness of cylinder walls, H. P. and L. P. 1 in., 1 1-8 ins.	
Steam pressure, designed	100 lbs.
R. P. M., designed	90
I. H. P., "	500
Crossheads, go-ahead bearing surf.	132 ins.
Shafting, crank, thrust, propeller	8 1-2 ins.
Main condenser, cooling surface	700 sq. ft.
Tubes, outside diameter	5-8 in.
Auxiliary condenser	300 sq. ft.
Boilers	two single-end Scotch
Diameter	10 ft. 6 ins.
Length	10 " 6 "
G. S., both	80 sq. ft.
H. S., "	2,520 " "
Tubes, 7 ft. long, 8 1-2 ins. outside diam.	
Furnaces	two each boiler
Least inside diameter	40 ins.
Donkey boiler	100 lbs. steam pres.

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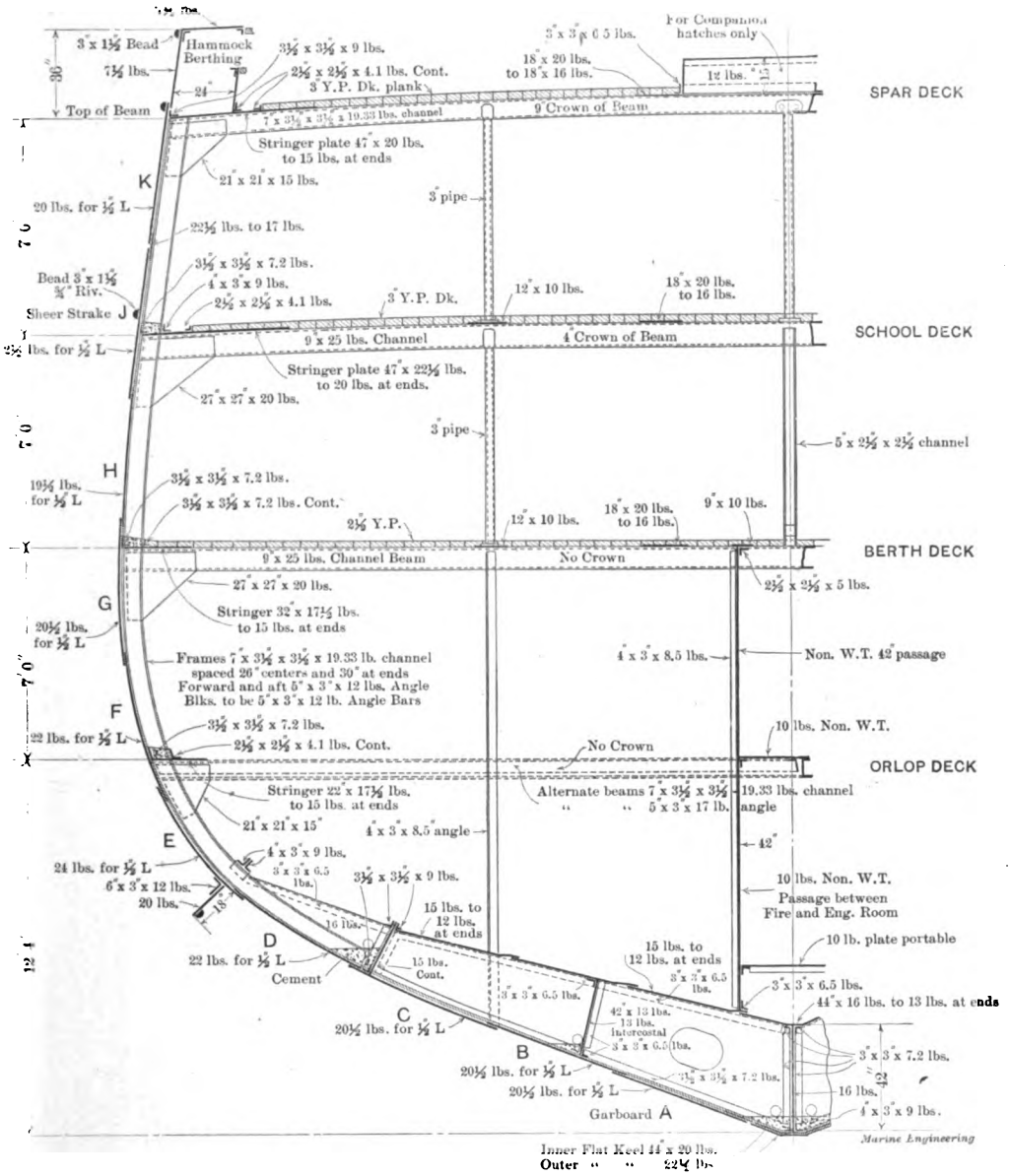
length of the ship under the berth deck, with several plugs conveniently located. The salt-water system of piping is very complete and is connected with the lavatories, tubs, etc.

Ventilation.—In the fire room are placed two steel fans of 10,000 cubic feet capacity at 1 1-2-ounce pressure, supplying fresh air to all the living quarters throughout the ship. A laundry plant is also installed, together with drying rooms.



MIDSHIP SECTION OF SHIP YOUNG AMERICA, BUILDING BY THE PERTH AMBOY SHIPBUILDING COMPANY.

columns of the engine, and the front of the engine will be supported by wrought-iron columns. An auxiliary condenser is placed in the fire room, and both will have combined air and circulating pumps. Each cylinder is fitted with a liner, and the high-pressure has a valve of the piston type, 8 1-2 inches in diameter, and the low-pressure has a slide valve. Both cylinders will be steam jacketed round the liners and at the top covers. The pistons are of cast iron, the rods of forged steel 3 1-2 inches in diameter, and the crossheads of forged steel; the slipper will be of cast iron with 132 square inches for forward surface and 100 square inches of backing surface. The connecting rod tapers from 3 1-4 inches at the upper end to 3 1-2 inches at the lower end. The valves are operated by the Stephenson link motion, the eccentrics and eccentric straps being of cast iron and the rods of forged steel. Reversing is accomplished by a steam cylinder 8 inches in diameter

MACHINERY.

The propelling engine consists of a vertical inverted direct-acting compound engine with high-pressure cylinder 22 inches and low-pressure 44 inches in diameter, the stroke of both pistons being 24 inches. When making 90 revolutions the indicated horse power at 100 pounds steam pressure will be about 500. The engine is mounted on cast-iron bed, with condenser in the back

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by 16 inches stroke, fitted with floating lever and a locking device.

The crank shaft is of forged steel with the slabs shrunk on. The propeller and thrust shafts are also forged steel, 8 1-2 inches diameter, made in one piece, that part of the shaft passing through the stern tube being fitted with a composition casing. The stern tube will consist of an iron or steel pipe flanged at the inboard and threaded at the outboard end. The propeller will be cast iron.

The boilers are Scotch marine type built according to the rules of the United States Boiler Inspectors. The tubes are 7 feet long in the clear, 2 1-2 inches external diameter. The smokestack will be about 50 feet high above grates, the upper 15 feet of it being made telescopic, with proper means for raising, lowering, and guiding same. The donkey boiler is placed forward on the berth deck, built for 100 pounds steam pressure. The pumps are the following sizes:

Feed pump, 4 inches, 10 by 10 inches, vertical double acting.

Donkey feed, 10 inches, 7 by 10 inches, vertical double acting.

Circulating pump.

Fresh-water pump, 4 1-2 inches, 6 by 6 inches, vertical double acting.

Brine and evaporator, 4 inches, 2 1-2 by 6 inches.

Deck, fire and bilge, 12 inches, 10 by 12 inches, vertical double acting.

Engine room, fire and bilge, 10 inches, 7 by 12 inches.

Main air and circulating.

Auxiliary boiler, feed, 3 1-2 inches, 2 1-2 by 4 inches.

An evaporator of 4,300 gallons of potable water in twenty-four hours will be installed, also two distillers, each condensing 2,000 gallons of water in twenty-four hours. The ship will be heated with steam throughout.

Orient-Pacific Liner Orontes.

The accompanying illustration and information concerning the engine of the Orient-Pacific *Orontes* are reproduced from *London Engineering*. The vessel, which is for the Australian mail and passenger service, was built by the Fairfield Shipbuilding and Engineering Company, Ltd., Govan, Scotland. The principal dimensions are to be found in the accompanying table. She has accommodations for 323 first- and second-class saloon passengers, besides many third-class. The cabins are arranged for one, two, or three passengers. Some of the inside rooms are built on the Bibby or tandem system, which gives these inner rooms light and air from the porthole in the side of the ship. The first-class dining saloon is on the upper deck. The smoking room is on the promenade deck, aft of the dining saloon, and the drawing and writing saloon on the same deck, forward. The second cabin and dining saloon are placed on the same deck, aft, extending from side to side, with seating capacity for 126 persons. Coaling is done through ports in the ship's sides, above the level of the main deck. The *Orontes* is on the Admiralty list of vessels suitable for armed cruisers.

The most striking feature in the design of each engine is the framing, which will be seen by referring to the engraving, gives free access to all cranks. The engines are quadruple expansion, with cylinders arranged on the Schlick-Tweedy system of balancing. The high-pressure cylinder is placed at the forward end, and next to it is the low-pressure cylinder, the cranks being at right angles. The two intermediate cylinders form the after pair, the first intermediate cylinder being the aftermost. The cranks of this pair are at right angles. The valves of the high and first intermediate are of the piston type, the others are flat, and all are worked by the Stephenson double motion.

There is a separate condenser for each engine, constructed of steel plates, and supplied with circulating water by centrifugal pumps driven by Allen engines. A feed pump, fitted to the main engine, raises the water to the feed heater and from thence it is pumped by two sets of independent Weir pumps to the boilers. The engine and boiler rooms are fitted most completely with auxiliaries. Electric current is generated by four sets of Allen compound engines and dynamos, of a total capacity of 110 K. W. A Brown steering engine is placed in the steering house on the boat deck, and is controlled from the bridge amidships by means of a telemotor. The usual steam windlass, winches, and capstans are supplied. There is also a large refrigerating plant installed, which is used in preserving the galley stores and also in refrigerating 74,000 cubic feet of the holds. The plant consists of two units, which work on the dry-air system.

Name—Orontes. Nationality—British. Type—Ocean passenger.
Launched—1902. Builder—Fairfield Shipbuilding and Engineering Company. Owner—Orient-Pacific Line.

Length of perpendiculars	530 ft.
Beam, molded	58 " 3 in.
Depth to upper deck	38 " 2 "
Load displacement	15,450 tons
Gross tonnage	9,000 tons
Engines	twin, quadruple
Arrangement	Schlick-Tweedy system
Cylinder diam, 27 1-4, 39, 56, and 80 ins.	
Stroke	60 in.
Valves...piston on H. P. and first I. P.	
Boilers	four single- and two double-end
Pressure	215 lbs.
Diameter	16 ft. 6 ins.
Length	19 ft. 8 ins. and 11 ft.
Number of furnaces, total	32
Heating surface, total	26,000 sq. ft.
I. H. P., total on trial	9,500
Speed on trial	18.18 knots.

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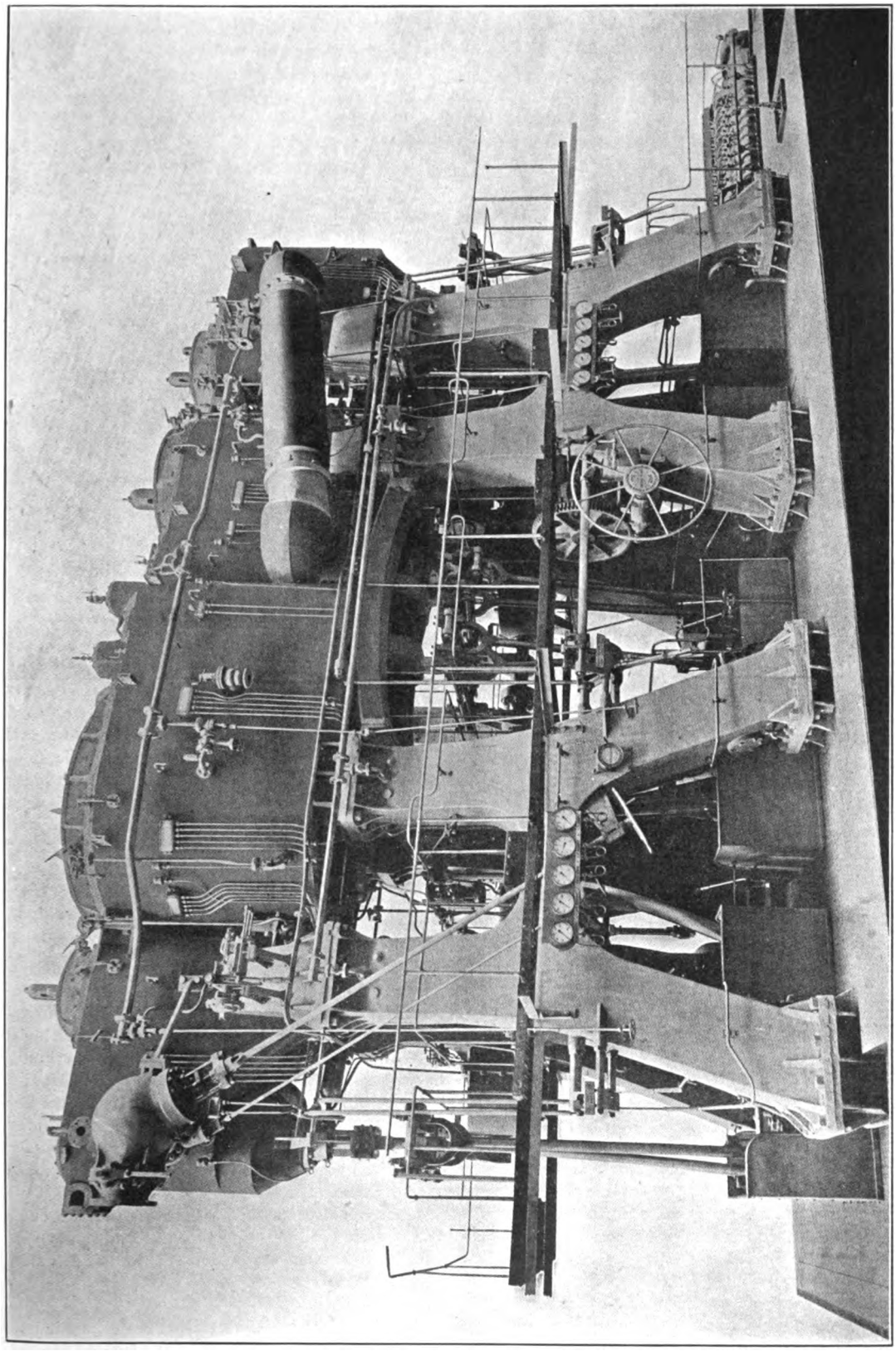

FOUR-CYLINDER QUADRUPLE-EXPANSION STARBOARD ENGINE ON THE STEAMSHIP ORONTES, BUILT BY THE FAIRFIELD SHIPBUILDING AND ENGINEERING COMPANY, LTD., GOVAN, SCOTLAND.

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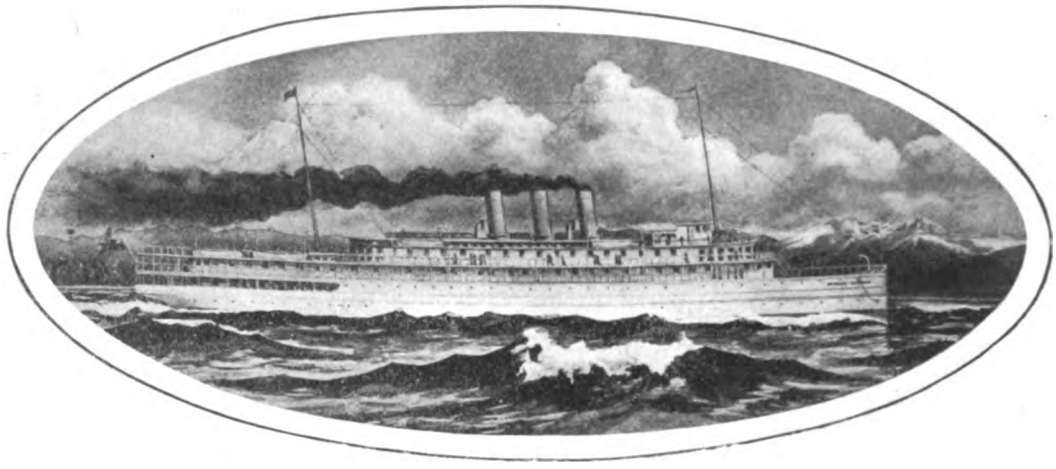
The boiler installation consists of two double-end and four single-end boilers, which are placed in two boiler rooms separated by water-tight bulkheads. The boilers are arranged to work on the Howden forced-draft system, four fans of large diameter being fitted on the boat deck near the funnel casing. Before leaving the builder's hands the *Orontes* attained a speed of 18.18 knots; this run was following a 12 hours' steaming at slightly-reduced power.



NEW STEAMER PRINCESS VICTORIA, FOR THE VANCOUVER-VICTORIA SERVICE OF THE CANADIAN PACIFIC RAILWAY COMPANY.

New Steamer for the Pacific Coast.

The *Princess Victoria*, recently built by C. S. Swan and Hunter Ltd., Newcastle-on-Tyne, England, for the Canadian Pacific, is a steel twin-screw steamer of the following leading dimensions: Length B. P. 300 feet, beam extreme 40 1-2 feet, and depth molded 18 1-2 feet. She has been designed for the company's mail and passenger service between the city of Vancouver and Victoria and will accommodate a large number of passengers, all above the hurricane deck. On the upper deck aft is a large deck house containing the dining saloon, with seating accommodation for 90 saloon passengers, and also the galley and pantry. From the after end of the engine casing to the stem the plating is carried up to the hurricane deck, and in this space at the after end are the rooms for the engineers, petty officers, etc., whilst forward the space is reserved for second-class passengers. On the hurricane deck is placed a large house, almost the whole width of the vessel and 245 feet in length. Along the sides are the state rooms for the first-class passengers; the space between these cabins being fitted up as an extensive sitting room, access being obtained to the dining saloon below by a commodious staircase aft of the engine room. At the forward end of this house, space is reserved for the second-class entrance and smoking room, and main staircase for first-class passengers to give access to the deck above, this deck having a large opening which gives this portion of the sitting room a lofty and handsome appearance. Only sufficient deck remains to make a gallery for access to the second tier of state rooms. The house on this deck extends for a length of 170 feet and is arranged similarly to the house below it, with state rooms at the sides. At the after end there is a comfortable smoking room, while the space at the forward end is fitted as an observation room with large square windows.

The vessel is of handsome appearance, has three funnels, and is rigged with two pole masts.

The machinery was built by R. and W. Hawthorn Leslie and Company, Ltd., and consists of two sets of triple-expansion engines working on four cranks and balanced on the Yarrow-Schlick-Tweedy system. The cylinders, 24, 40, 43 1-2, and 43 1-2 inches diameter, with a common stroke of 33 inches, are expected to develop about 5,500 indicated horse power on the trial trip. Steam is supplied by six single-end boilers, each 15 feet diameter by 11 feet long, working at a pressure of 160 pounds per square inch. The draft will be assisted by fans, giving modified forced draft. This machinery is expected to drive the vessel at a speed of 18 knots an hour in service.

Causes of Delay in Building Warships.

The report of Rear Admiral Bowles, Chief Constructor of the Navy, on the question of the delays in the completion of the United States warships, is a large document and goes into much detail. Practically no ship contracted for by the government has been delivered on time. The causes for the delays are attributed to the following facts: First, incomplete plans; second, changes in designs after the awarding of the contract; third, delays in delivery of armor, due to several causes, among which are improved methods of manufacture of armor, and in some cases refusal of Congress to authorize the department to contract for armor; fourth, a thorough system of inspection; fifth, inability of the builders to secure material on time; sixth, inadequate supply of skilled workmen or insufficient technical staff at the builder's yard.

Monitor Nevada.—The United States monitor *Nevada*, which for several years has been under construction at the Bath Iron Works, was turned over to the government at the Portsmouth Navy Yard March 5.

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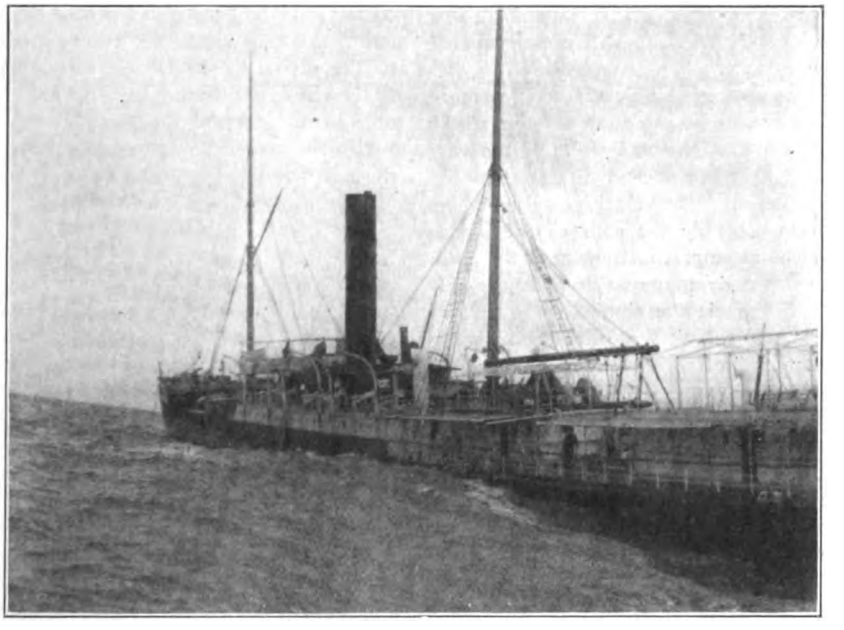
The Loss of the Madiana.

On the clear night of February 10 the Quebec Steamship Company's ship *Madiana* struck a reef off the coast of Bermuda and at once sank on a ledge. It was 4 o'clock when the vessel struck and five minutes later the saloon was filled with water. A heavy sea was running at the time, but fortunately the ship held to the ledge, otherwise she might have gone down with all on board. At daylight assistance arrived and the passengers were taken off on tugboats. The governor of the island appointed a marine court of inquiry to investigate the circumstances attending the loss of the ship, and a brief of the findings of the court is as follows:

From the sights taken at 8.30 A.M. and at noon on the day before the accident, the master set his course for a point seven miles east of St. David's Light, and, according to the testimony, the course was not altered until within a few minutes of the ship striking. The two sights did not agree and the master discarded his morning sight and based his calculations on the noon sight. Evidently the morning observation was the correct one. As the master had run the course as laid down to a point seven miles east of St. David's and failed to pick up the Light, he should have run slowly and not at full speed as was the case. The visibility of Gibb's Hill Light had been decreased a few months previous to this time, owing to the lighthouse being struck by lightning. The master was not acquainted with this fact. The ship's log was not presented before the court. The court also recommended that only men who can understand and speak English should be employed to steer British passenger ships. On board the *Madiana* there were Italian helmsmen. No officers' certificates were canceled.



STEAMER MADIANA, ASHORE ON A REEF OFF THE ISLANDS OF BERMUDA.

EFFICIENCY OF PROPELLERS AND RUDDERS.

BY GEORGE H. WILSON.

The question as to the best location for the propellers and rudder of a vessel is one that has received a great deal of attention from time to time, resulting in various opinions and theories as to the proper solution thereof. Some of the best authorities and ablest men among naval architects have dealt with this subject, pointing out the various good features of certain systems and the bad ones of others, among whom are such men as Rankine, Froude, Tideman, Reynolds, Durand, Isherwood, and Taylor. With such men collaborating on the same subject, although with varied ideas, it would be reasonable to suppose that a solution had been effected. Beyond a doubt the experiments made have been of invaluable aid to the profession, but it seems as if one or two of the most important thoughts promulgated by these researches have not been much improved upon.

The points to which I refer, and which will be dealt with in this article, are the changes in the location of the rudder and the altered position of the propellers proposed by some of the above authorities. To effect an improvement in the steering qualities of a vessel and to increase the propulsive coefficient must be the aim of any change in this direction.

In the propeller experiments made by Professor Rankine, some points of which bear upon this subject, he assumed as a basis for his investigation that the number and surface of the blades in a screw would be adjusted by rules derived from practical experience, so that the stream flowing aft would consist of the whole cylinder of water in which the screw revolved; that is to say, the race was assumed to consist of a cylindrical column of water having the screw disc, less the area of the boss, for its athwartship section, the motions of the particles assuming a spiral path.

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On these assumptions it was possible to approximate, (1) to the quantity of water acted upon in a given time; (2) to the sternward momentum generated in the same time; (3) to the loss of thrust due to friction; (4) to the effect on the efficiency of the screw due to working in water previously disturbed by the vessel. In connection with the subject in hand we have to deal with number 2 as regards the spiral character given to the particles, and with number 4 in toto, reference to which will occur later.

The investigations made by the late Mr. Froude were along entirely different lines and had to deal with the frictional and normal resistance of each unit of area of the various blades, the summation of which was taken as the approximate total effect of the propeller. The aggregate effect must necessarily be approximate, owing to the disturbed condition of the water over different areas due to the friction from adjacent areas, friction from other blades and from the wake of the vessel. Here again the question of the disturbance of the element in which tne propeller is working is brought out as a salient feature of its efficiency. As this point is one that affects the subject in hand, it will not be out of place to dwell on the same.

Prof. Reynolds says that the single screw is at more of a disadvantage than the twin screw, as the whole propeller is working in the frictional wake of the vessel, the upper blades exerting greater thrust than the lower ones owing to the different velocities of the wake. while the twin screw has only the ends of the blades working in it. I will attempt to show that the twin screw is at a greater disadvantage as regards the difference of the thrust than is the single screw, and to support this theory I will submit the following reasons:

1. The "frictional wake" of a vessel, it is well known, is a body of water adjacent to the skin of the vessel, which by reason of frictional contact with the same assumes a motion similar to that of the vessel, although with somewhat less velocity. The distance over which this friction exerts an influence on the particles of water varies with the nature of the skin and also as the speed of the vessel.

2. The vessel having given a forward motion to a body of water in its immediate vicinity, it follows that there must be some region, not affected by the motion of the vessel, where the water is at rest. Lying between the two must be a region of disturbed water having a vacillating tendency. As the force exerted on one side tends to give it a forward motion and the inaction on the opposite side tends to retard, it is obvious that an eddying effect must be the result, with a slight tendency toward a transverse motion.

3. Beyond these disturbed elements lies that body of water which is not affected by the passage of the vessel and is consequently at rest.

With these influences acting on the water approaching the propeller, the following conditions of water in which the propeller is working can be deduced and divided to suit the foregoing subdivisions:

1. The water nearest the ship, the frictional wake, has a forward motion, the speed of which is somewhat less than the speed of the vessel. This has the effect of making that body of water, relatively, a body of nearly still water as regards the propeller.

2. The water outboard of, and adjacent to, the wake has a forward-athwartship motion imparted to it, which condition is in the nature of an eddy.

3. The water outboard of all the foregoing has no motion at all imparted to it by the vessel.

Analyzing these subdivisions, some approximation to the relative effect of each on the efficiency of the propeller can be reached.

In regard to No. 1, it is found that about two-thirds of the propeller blade, when at a point near the skin of the vessel, are working under this condition. In this instance the greatest effective thrust is experienced. In No. 2, the thrust is somewhat diminished, but owing to the narrower parts of the blades and the hub being in this region, the effect is not so great. In the case of No. 3 the thrust is further diminished and should be at a minimum. The last condition affects somewhat less than that two-thirds of the blade farthest from the skin of the vessel.

With the above conditions of water in the neighborhood of the propellers and the consequent variations in the thrust, it can readily be seen that these conditions are responsible for a certain amount of the shocks and vibrations which are transmitted from this region to the propeller shafts and thence to the engines and to the ship. As these vibrations are always more noticeable in and around the stern of the vessel, it goes to verify the statement that certain of them must originate in that vicinity.

It is hardly possible to remedy the defects in the efficiency of the propeller due to the causes just mentioned, as it would necessitate placing the propellers either at a greater distance out from the side of the vessel, or at a considerable distance abaft of the stern post, so as to allow of their working in an element where the conditions are similar, both of which must be discarded owing to their impracticability. The efficiency of the propellers can, however, be increased in one way to a certain degree.

Aside from the complex conditions of the water in which the propellers are working, the angle at which the stream lines approach the propellers should be taken into consideration. In vessels having a very long run and necessarily fine lines, this angle is very small and of no great consequence, but in vessels with a short run the angle is of considerable import. It goes without saying that a propeller will have the maximum efficiency, everything being equal, where the water is brought to it in lines of flow parallel to its axis. This, of course, is a condition hardly obtainable with some of the present constructions and lines, but this defect can be partly overcome and somewhat remedied by changing the location of the propellers, as shown.

With this idea in mind it is suggested that the propellers be located at the farthest practical point astern. This would, of course, be the position occupied at present by the rudder. It is just this shifting of the positions of these two functions of a vessel that the author would advise; to place the twin screws where the rudder is now located, and *vice versa*, as is shown in sketches numbers 2A and 2B.

The advantages gained from this alteration of the position of these two functions I will separate under four heads, as follows:

A. Increased efficiency of propellers, due to working in nearly parallel stream lines.

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B. Increased efficiency of rudder, due to working in more advantageous stream lines.

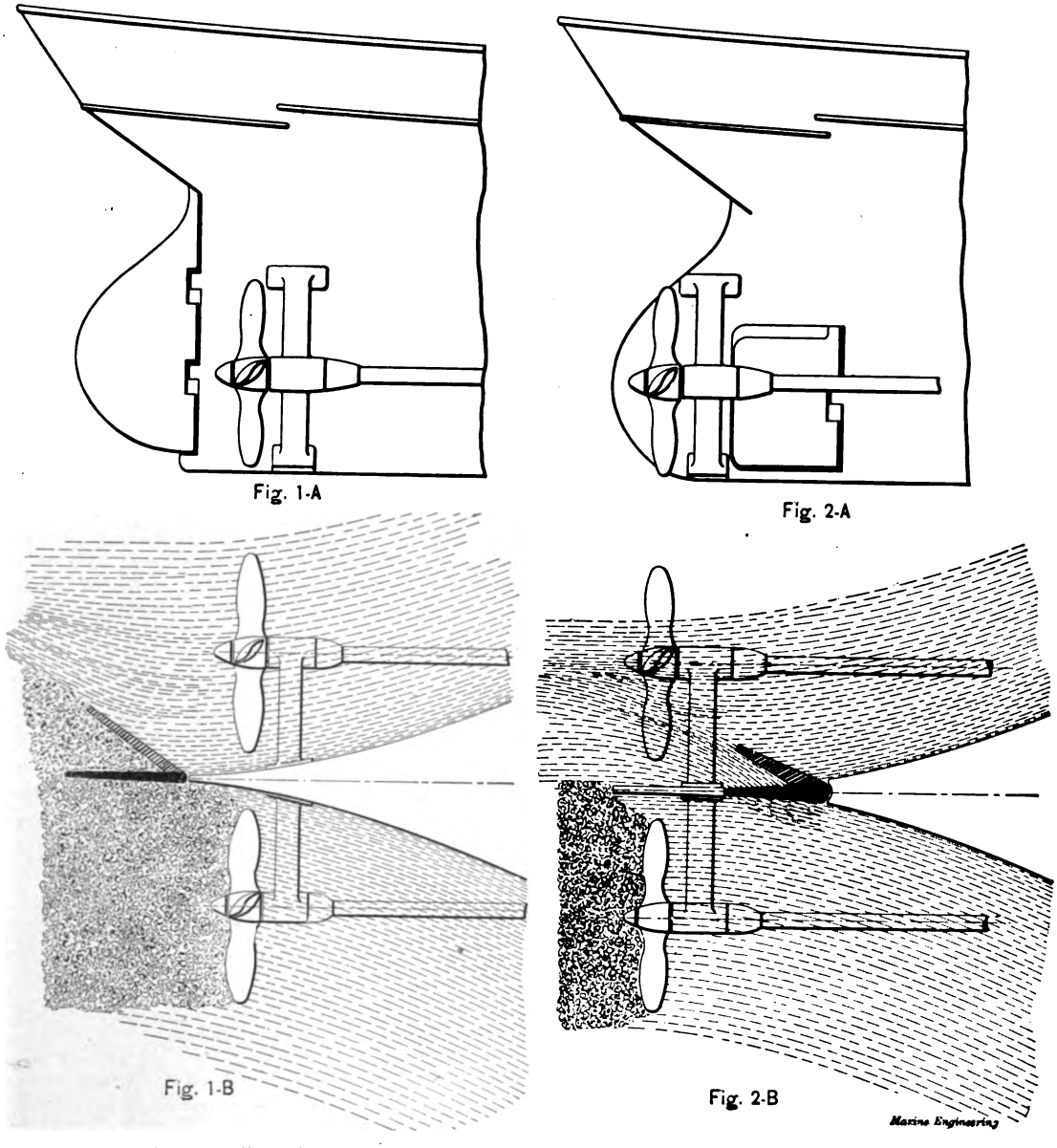
C. Increased efficiency of rudder, due to working in better conditions of water.

D. Increase in the thrust properties of the stern stream lines.

As regards the first of these headings, it is seen by referring to sketch number 2B, previously mentioned, that the angle of the stream lines at the propeller is considerably reduced from that shown at the same relative point in sketch number 1B. The action of the stream lines in the former sketch is to exert their maximum efficiency on the propeller blades, while with the water advancing to the propeller at a considerable angle, as in the latter sketch, there is a tendency for the particles to slip off before performing in full their function of resistance.

As the proposed location of the propellers gains for them the action of nearly parallel water lines or stream lines, the conditions cited in the latter case above are obviated.

In connection with the shifting of the propellers and the rudders, some of the earlier model trials by the late Mr. Froude gave a certain amount of data, but the accuracy of these is hardly accepted at the present day. Any increase in power, however, gained by shifting the propellers aft, is, no doubt, caused by a decrease in the resistance of the vessel owing to the stern stream lines being less affected, but a portion of this gain would be due to the fact of the propeller working in better conditions of water. It is suggested that the gain effected by the thrust of the stern stream lines would be nearly overcome by the loss due from the wake gain of the propeller. I hold that the shifting of



STREAM LINES FOR THE USUAL, AND SUGGESTED NEW LOCATION OF RUDDERS AND TWIN SCREWS.

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the propeller a certain distance aft does not prohibit the propeller from gaining something from the frictional wake, as it is well known that that body of water drags along after the stern a considerable distance. The gain would not, of course, be so great as in the other case, yet I doubt if the difference will counteract the gain from the thrust spoken of above.

As regards the second subdivision, *B*, "Increased Efficiency of Rudder, Due to Working in More Advantageous Stream Lines," there are one or two points to discuss. I think that when I make the assertion that by placing the rudder in the position shown in sketches numbers 2A and B the efficiency has been increased, I will not be contradicted. It is well known that the maximum efficiency of a rudder for turning effect would be with the rudder at an angle of about 45 degrees, were it not for the skin friction and other causes. Owing to these the angle of about 30 to 35 degrees has been found to give the best results.

In the present location of the rudder the stream lines are practically parallel to the center line of the vessel. In the proposed location the stream lines would form a considerable angle with the center line. As the turning effect of a rudder is dependent upon the angle of its face with the water approaching, it necessarily follows that the angle of the stream lines plays an important part in this connection. With the rudder in the position shown in sketch number 1B, when turned at an angle of 35 degrees, the angle of impact of the stream lines is about 145 degrees. To obtain the same angle of impact with the rudder in the proposed location, as shown in sketch number 2B, an angle of about 27 degrees is all that is required for turning. The result of this decrease in the turning angle is clearly a gain in favor of the latter proposition. Although the angle of turning has been reduced, the fact that the rudder is working in angular stream lines prevents a like decrease in the moments and strains due to twisting. The reduction in the amount of travel, however, of the different parts, in connection with the rudder, tiller, steering ropes, and engines, allows of the decrease in size of a number of these parts, causing a like reduction in weight. Owing to the reduced motion of the working parts and to the new location of the rudder, which is at a beamier part of the vessel, all of this gear can be carried lower down, thus insuring (in the case of a man-of-war) a perfect protection for these parts.

On the subject coming under the heading marked *C* a great deal can be said. It has been argued, when the positions of rudder and propeller are in question, that it is necessary to have the rudder abaft the propeller, so that a vessel with little or no headway would still have steerageway by reason of the action of the propeller race on the rudder. This argument would hold good for single-screw vessels, but it hardly seems adapted to the twin-screw type. By referring to sketch number 1B, it will be seen that the propeller on the side opposite to the one to which the rudder has been turned, if given an ahead motion, will materially aid in the steering, but will have no action on the rudder whatever. On the opposite side of vessel, however, the propeller will aid the steering effect of the rudder, but will counteract this effect by the contrary turning moment of its own action. This disproves the argument just mentioned.

As regards the action of the rudder on the stream lines running to the propellers, the new location has an advantage, in that when the rudder is hard over, with both propellers going full speed ahead, the propeller necessary to aid in the turning is unaffected, while to the one detrimental to turning the stream lines are interrupted, decreasing its efficiency to a considerable extent, and thereby aiding in the turning of the vessel.

With one propeller going full speed ahead and with the other stationary the rudder in the new location has also an advantage over the rudder in the old position. In the old position, with the propellers working as mentioned, the rudder will, of course, be turned toward the stationary wheel; this propeller is dragging a certain amount of water along behind it, causing eddies, etc., or, in other words, is keeping a certain amount of water from acting on the rudder at all, and is disturbing nearly all the water in that region, so that the efficiency of the stream lines acting on the rudder is reduced by about one-half. This state of affairs could not exist with the rudder located as I have suggested, as the solid stream lines, with their initial momentum, would act on the rudder and would then go to the propellers, where they can do but little harm.

With the two propellers working in opposite directions the rudder plays but a small part in the turning of the vessel, but even in this instance the proposed new position has the advantage over the old. As the vessel has a certain amount of headway, this will act with the rudder in the new position in helping to turn the vessel, while with the rudder in the old position the propeller would draw all the water away from the working face of the rudder.

With both propellers out of action the forward position is undoubtedly the best position for the rudder, as was the case with one wheel going ahead and one wheel stationary.

These various conditions of running and turning having been discussed, it is easily seen that the new position of the rudder has the advantage in every case.

The last heading remains for consideration, and, although referred to previously in this article, I deem it necessary to revert to it at this point. It is a well-known fact that as the stream lines travel aft along the ship's side and bottom they close in around the stern and in so doing exert a forward pressure on the vessel, which helps to counteract the resistance experienced when pushing these stream lines outward at the forward part of the ship. In the present location the propellers tend to draw these stream lines away from the stern before they have performed the above duty. Therefore, thrust deduction. Were it possible to so locate the propelling power that the stream lines would be unaffected until after having performed their thrust properties, there is little doubt that there would be an increase in speed. The wake gain would, however, be reduced, as previously mentioned, but, owing to the wake extending some distance abaft the stern, I doubt if there will be enough reduction to counteract the above gain.

This location of the propelling power being impracticable, it remains to place the disturbing agency as far aft as possible. To do this is not only possible, but is also very practicable, as will be seen by reference to sketches numbers 2A and B, which give a good idea

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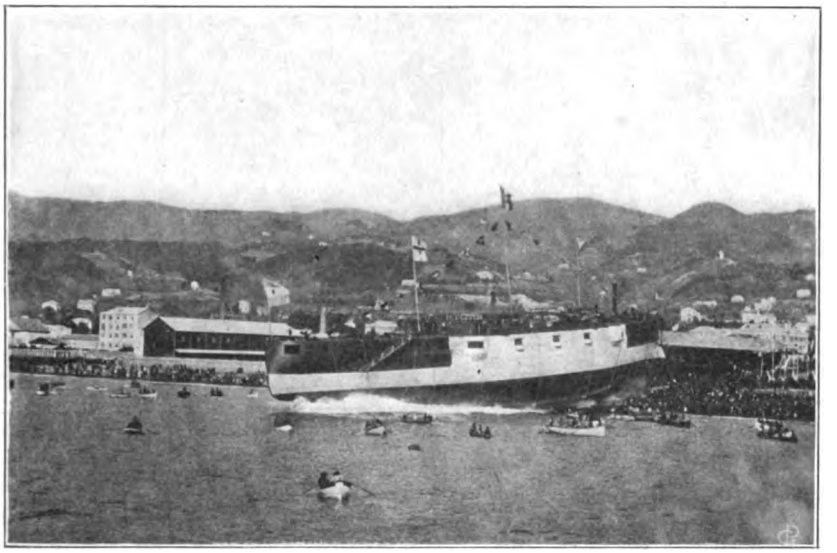
of the shape of a stern to allow for this development. In the case of vessels of a certain shape of stern the load-water line can be decreased in length to some extent. From this sketch it will be seen that there are no structural difficulties in the way of this arrangement.

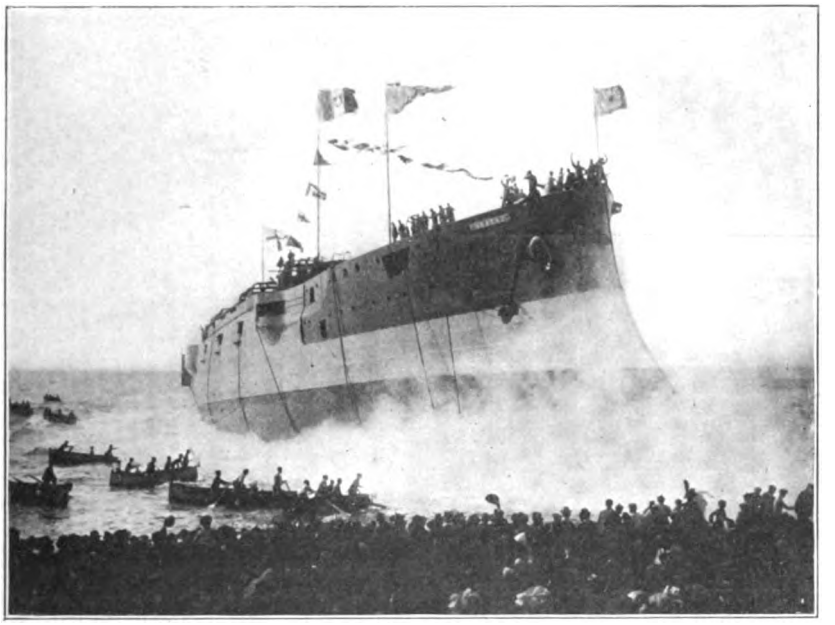
It may be a surprise to some that this arrangement has been patented for some time, but patents were granted in this country and in Europe to Mr. Walfrid Sylven, on "Improvements in the Construction of Steamships and Rudders and in Locating Rudders and Propellers."

The author is indebted to Mr. Sylven for selections from his work on this subject, which have been incorporated in this article.

Another Picturesque Launch.

The correspondent from Genoa sends us the accompanying views of the launch of the battleship *Moreno*, built by Messrs. Ansaldo and Company for the Argentine Republic. The launch took place on February 9, and was witnessed by a large crowd both ashore and afloat. The ship is a sister ship of the *Rivadavia*, previously described in these columns. On an occasion of such a launch as this, the shipbuilders throw open the yard to the public and the business in the town is practically suspended, so that all may witness the launch. This yard, located in the little seaport of Sampierdarena, near Genoa, as is seen in the view, lies at the foot of hills covered with gardens and vineyards. The ship





TWO VIEWS TAKEN AT THE LAUNCH OF THE ARGENTINE BATTLESHIP MORENO, AT SAMPIERDARENA, GENOA, ITALY.

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was launched with the usual Italian ceremony, consisting of a priest pronouncing a benediction as the ship went overboard.

Name—Moreno. **Nationality**—Argentine Republic **Type**—Battleship.
Launched—Feb. 3, 1903. **Builder**—Ansaldo and Company. **Owner**—Argentine Republic.

Length over all	357 ft.
Between perps	344 "
Beam, extreme	61 " 4 ins.
Depth	40 "
Launching weight	3,000 tons
Mean load draft	24 ft.
Corresponding displacement	7,700 tons
Coal supply, maximum	1,100 tons
Steaming radius at 10 knots	9 000 miles

Engines, type	twin-screw, triple expansion
Cylinder diam	42 1-2, 63, 92 3-4 ins.
Stroke	46 "
Cooling surf. condensers, each	6,910 sq. ft.
I. H. P., designed	13,500
Speed, "	20 knots.
Boilers, number of	four double-end, four single-end Scotch.
Steam pressure	165 lbs.
G. S.	893 sq. ft.
H. S.	24,272 " "

Steamship Maine.—On February 11 the steamship *Maine*, one of the six large ships being built for the Atlantic Transport Company in American yards, was launched from the works of the Maryland Steel Company, Sparrow's Point, Md. The over-all length of the *Maine* is 507 feet; beam, 58 feet; draft, loaded, 27 feet 4 inches; displacement, loaded, 17,200 tons. A general description of this ship was given in Marine Engineering of January, 1903.

Lighthouse Tender Heather.—In the presence of a number of naval officers the lighthouse tender *Heather* was launched on November 17 from the yard of Moran Bros. Company, Seattle, Wash. The vessel is built for the United States Lighthouse Service and the principal dimensions are as follows: Length over all, 178 feet 5 inches; between perpendiculars, 165 feet; beam, molded, 28 feet 6 inches; depth of hold from top of keel to top of beam, 14 feet 11 inches. The boilers and machinery are now being installed, and it is expected that the vessel will be delivered early in April.

Novel Way of Making a Joint.

There are many ways of making a joint, but that which was done by my chief on board the S. S. ——— is the only thing of the kind I have ever heard of. The joint on the bonnet of the main feed check valve blew out on the after boiler and it was impossible to shut the valve or hold the water in the main boiler, although the extra feed, donkey, sanitary pumps were all on; when the ship rolled we could see the water in the glass. The assistant on watch called the chief engineer down below and expected to see the fires drawn and a new joint made, which would take at least ten hours.

The old joint was made up with wire gauze between steam rubber, and the rubber blew out, leaving the gauze in place. The chief called for a piece of hemp rope and had it cut up into 2-inch lengths, and then, standing over the filter box, he unraveled the pieces and dropped them into the water. Inside of half an hour the joint was made and did not leak a drop. The hemp strands were carried over with the water by the feed pump, and as the water escaped through the leak the strands caught in the gauze and were woven through it like a basket. The gasket made would be hard to duplicate, and it may still be seen in the "old man's" room as a sample of engineering originality. Cadet.

AN ICE-COATED ANCHOR DAVIT.

Wireless Telegraphy.—On a recent passage the steamship *Etruria* published a daily newspaper with dispatches received by wireless telegraphy from the stations on each side of the Atlantic.

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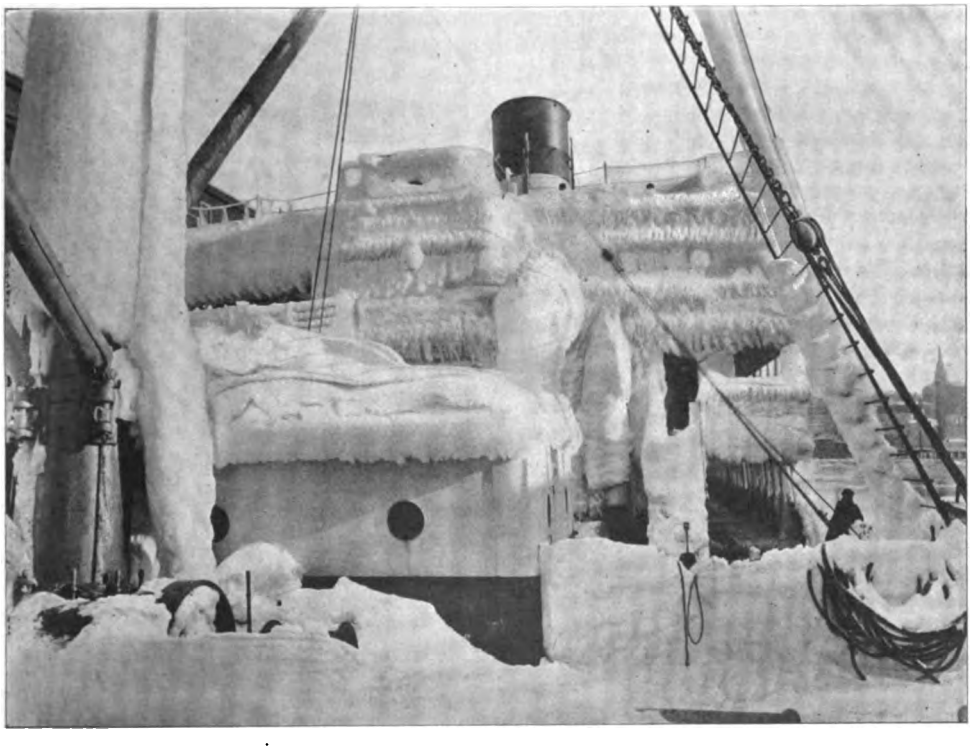
Ice-Decked Steamers.

The past winter has been a record breaker for storms at sea and the shipyards of this coast have been filled with repair work of both large and small craft. The hardships in navigating the tempestuous North Atlantic during the winter months may be inferred by looking at the accompanying pictures, taken on board two steamers which had experienced what may be termed a rough passage. The flying spray froze to anything it came in contact with, and the shrouds and rigging were increased many times in size. Another winter season has closed and we may now look for calm seas.



DECK VIEWS OF TWO STEAMERS IN PORT AFTER A COLD AND ROUGH PASSAGE ON THE NORTH ATLANTIC.

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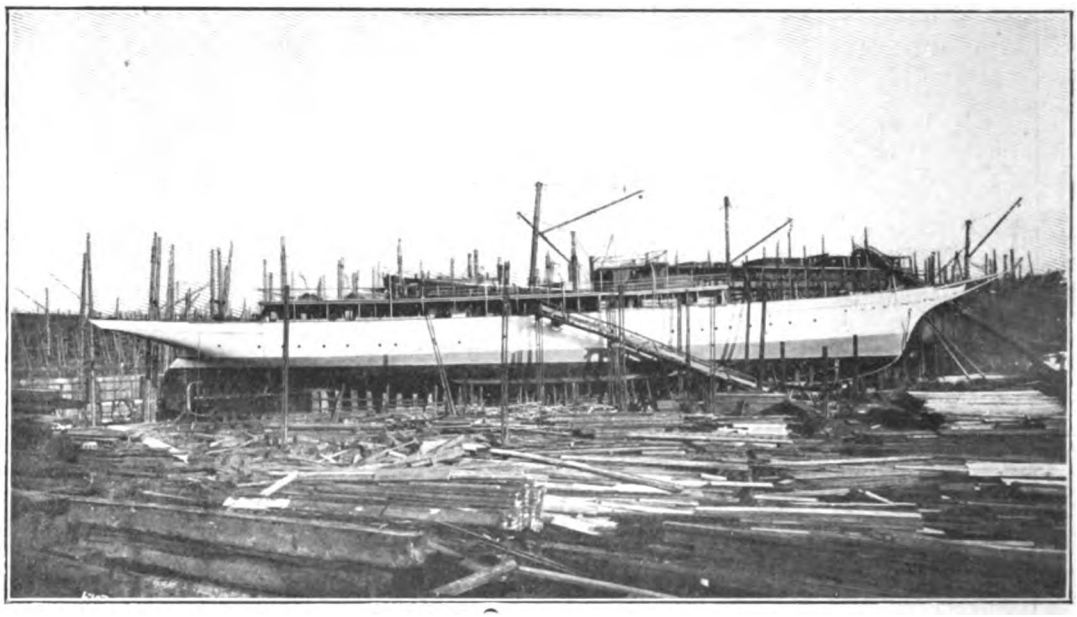
Modern Steam Turbine Yachts.

BY FRANK C. PERKINS.

The marine steam turbine is rapidly finding its way into service for the propulsion of modern high-speed yachts. It may be of interest to consider a few details of construction of some of these boats, and the accompanying illustrations, Figs. 1, 2, and 3, show one of these boats under construction, as well as the shipbuilding shed, yard, and shops at Glasgow where they are built.

The turbine steam yacht *Emerald* was constructed at the plant of Alexander Stephen and Sons, Ltd., of Linthouse, Govan, Scotland. The shops are thoroughly equipped with the latest machine tools, jib and traveling cranes, and the shipbuilding yard has an ideal location for the construction and launching of these boats.



STEAM TURBINE YACHT EMERALD.

The *Emerald* is equipped with three sets of steam turbines of the Parsons marine type, each driving a single length of shafting, with an aggregate developed horse power of 1,500. Of the three shafts which are directly connected to the steam turbines, the two outside shafts each have two propellers of about 20 inches diameter. The central shaft is fitted with one propeller about 36 inches in diameter, and all of these wheels are constructed of manganese bronze.

The length of the *Emerald* is 236 feet, the depth 18 1-2 feet, and the beam 28 2-3 feet; the above dimensions giving a tonnage of 1,512,000 pounds, yacht measurement. It is stated that a speed of 16 knots per hour can easily be attained with an entire freedom from vibration.

The steam turbine yacht *Tarantula* was constructed for a speed of 24 knots per hour, and has a 16-foot beam and a total length of 160 feet. The turbines for this boat developed 2,500 H.P. and are three in number. Two of the turbines are of the Parsons low-pressure type, which drive the two outer shafts, each of which is provided with three screws. The high-pressure turbine is connected with the central shaft, which also has three propellers, making a total of nine screws in all. This yacht is owned by Col. H. McCalmont. The boiler is of the Yarrow water-tube type, and the general construction of the yacht is along the lines of the torpedo-boat class.

Another interesting high-speed steam turbine yacht is the *Lorene*, being constructed for Mr. A. L. Barber, New York city. This yacht is 260 feet 8 inches long, and has a beam 33 feet 3 inches, while its displacement is 2,800,000 pounds. The turbines for this boat, which is being built at Leith, Scotland, are also of the Parsons marine type, and the boilers and hull were designed by Ramage and Ferguson.

The first marine steam turbine boat, constructed several years ago, known as the *Turbinia*, it will be remembered, made the high speed of nearly 35 knots, with a total of over 2,000 H.P. Soon after the torpedo-boat destroyers *Viper* and the *Cobra* were constructed, with a speed of from 35 to 40 knots, and later were built the steam turbine passenger boats *Queen Alexandra* and *King Edward*, which have both given excellent satisfaction, and a number of vessels are now being constructed, and are proposed, utilizing steam turbines instead of the reciprocating engine. It is claimed by Mr. Parsons that the use of several screws on each propeller shaft has a decided advantage over a single screw of larger dimensions, when the propeller shaft is operated at the high speeds necessary for running steam turbines.

Spare Parts Dutiable.—The attorney-general has rendered a decision whereby spare parts of machinery imported to this country by foreign steamship lines and held in reserve on the wharves at American ports are subject to duty the same as other machinery of this class. The only exception to be made is in case such parts are to be brought over to meet an emergency that already exists. The decision is the result of an application made by the Cunard Steamship Company to land a steel shaft without payment of duty, which was to be kept on the company's dock at New York for use on the steamship *Umbria* or *Etruria* in case of emergency.

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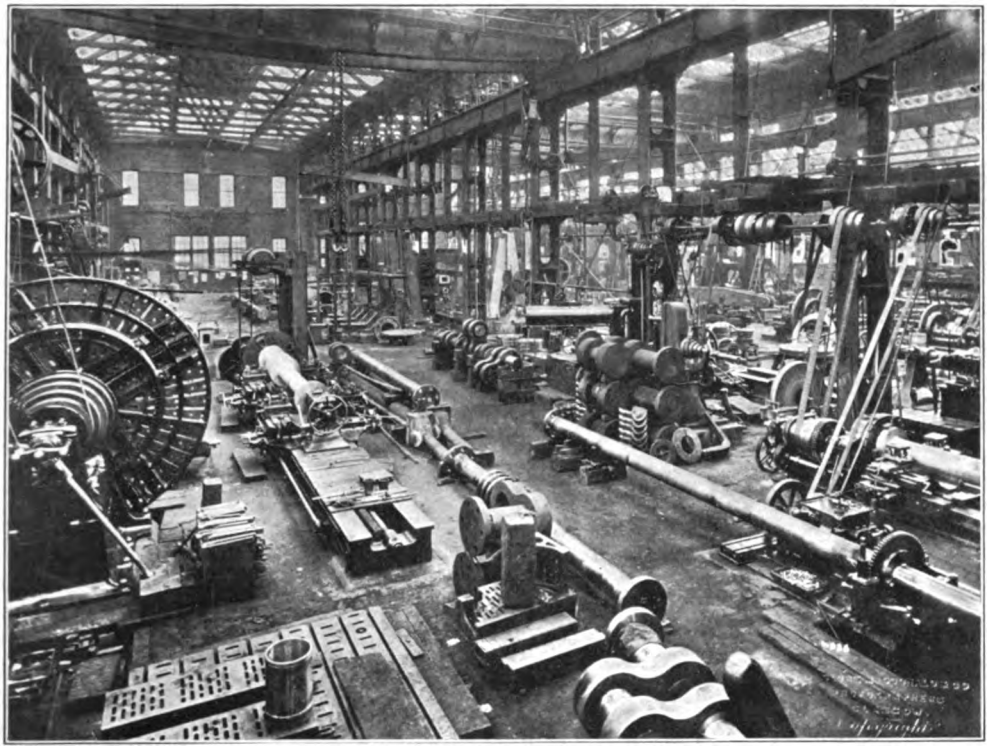

MACHINE SHOP.

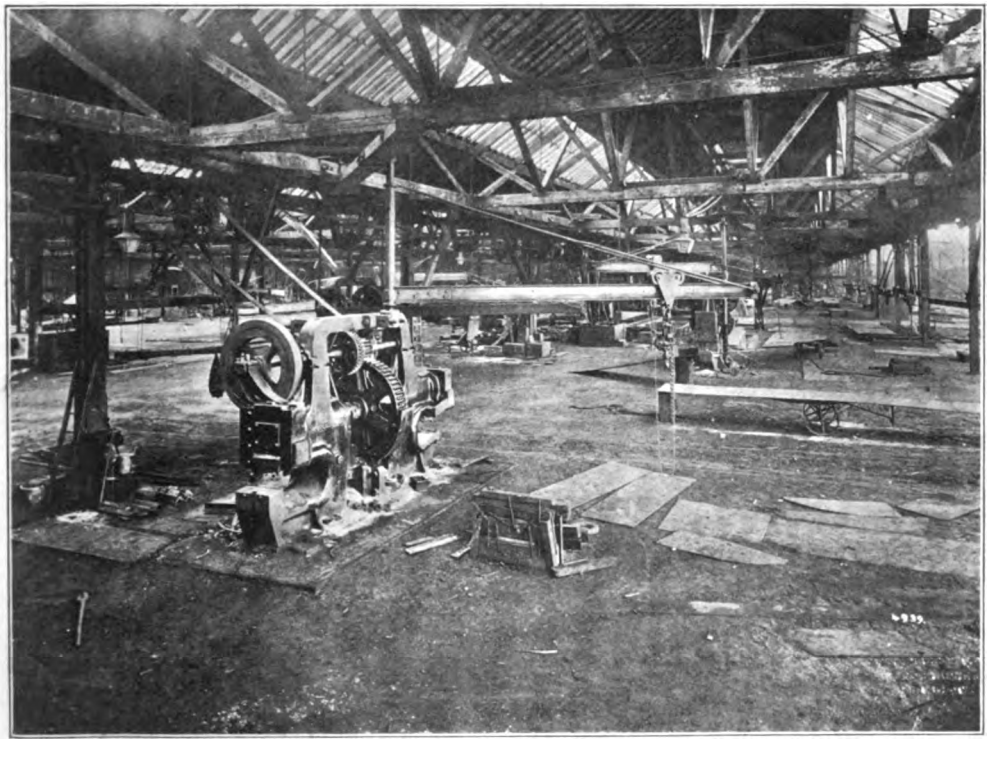

PLATE SHED.

VIEWS AT THE SHIPYARD OF ALEXANDER STEPHEN AND SONS, LTD., GOVAN, SCOTLAND.

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TRIPLE-EXPANSION TWIN-SCREW PROPELLING ENGINES OF THE U. S. BATTLESHIPS CONNECTICUT AND LOUISIANA.

The latest battleships contracted for by the United States government are numbers 18 and 19, which have been named *Connecticut* and *Louisiana* respectively. The former one is to be laid down at the Brooklyn Navy Yard and the latter one is under construction at the Newport News Shipbuilding and Dry-Dock Company. As previously stated in these columns, it is the aim of the Navy Department to have all details of these ships identical, in order that a fair comparison may be made between the cost of navy-built vessels and those built by private contractors.

In preparing the plans for these battleships the Bureaus of Construction and Repair and of Steam Engineering have prepared the plans and specifications with the greatest care and detail in all particulars.

The propelling engines will be right and left hand, placed in water-tight compartments, separated by a middle-line bulkhead. The engines will be of the usual vertical, inverted, direct-acting, triple-expansion, four-cylinder type, the diameters of the cylinders of each engine being 32 1-2, 53, 61, and 61 inches, the stroke of all pistons 48 inches. With a pressure of 250 pounds of steam in the high-pressure cylinder, the engines are designed to make 120 revolutions per minute and indicate 16,500 horse power.

The arrangement of the cylinders from forward aft is, forward low-pressure, high-pressure, intermediate-pressure, and after low-pressure. The forward pair of cylinders have cranks opposite each other, as have also the second pair, the second pair being at right angles with the first; thus the sequence of cranks will be, high-pressure, intermediate-pressure, forward low-pressure. after low-pressure. This arrangement may be modified later if it is found that by so doing there will be less vibration of machinery. There will be one piston valve on the high-pressure cylinder and two on each of the intermediate and low-pressure cylinders, all valves being worked by Stephenson link motion. The engine bed plates will be of cast-steel supported on the keelson plates, and the framing will consist of forged-steel columns trussed by forged-steel staves. Hollow shafting is to be used throughout, and, with the piston rods, connecting rods, and other working parts, will be forged of open-hearth steel.

Each main condenser will have a cooling surface of about 10,375 square feet, measured on the outside of the tubes. For each condenser there will be an independent air pump of the double, vertical, single-acting type and a main centrifugal pump. There are four auxiliary condensers, one of 550 square feet in each engine room, and one of 950 square feet of cooling surface in each dynamo room for the exclusive use of the dynamo engines. All the auxiliary condensers are fitted with an air and circulating pump.

The boiler equipment consists of twelve water-tube boilers of the Babcock and Wilcox marine type, placed in six water-tight compartments. The total grate surface will be about 1,100 square feet and the total heating surface about 46,750 square feet. A system of forced draft is supplied by blowers discharging into the air-tight fire rooms, with two blowers for each boiler compartment. There will be two main feed pumps, a fire and bilge pump, a hot-well pump, and a bilge pump driven from the forward end crank shaft in each engine room. An auxiliary feed pump will be placed in each boiler room. This list of auxiliaries includes ash hoists, turning engines, auxiliary pumps, refrigerating machinery, motors for workshop, distillers and evaporators, steam reversing gears, etc.

The cylinders are to be of close-grained cast-iron, and each cylinder and valve chest is to be fitted with a cast-iron liner. All the cylinders will be steam-jacketed round the working liners, and the intermediate- and low-pressure cylinders jacketed at both ends. The jacket steam will pass successively through the high-pressure, intermediate- and low-pressure jackets, with reducing valves on the two latter cylinders. An adjustable spring relief valve, 3 1-2 inches diameter, is fitted at each end of each cylinder. All cylinders and valves are drained. From the outboard side of each low-pressure valve chest there will be a 22 1-2-inch copper exhaust pipe leading to condenser. There will also be two receiver pipes on the outboard side connecting the high- and intermediate-pressure valve chests and 11 inches in diameter; from a 20-inch outlet on the outboard side of the intermediate chest a copper receiver pipe will lead with a 16 1-2-inch branch to each low-pressure valve chest, and each of these branches will again branch into two 11 1-2-inch

Name—Connecticut. Nationality—American. Type—Battleship.
Builder - Brooklyn Navy Yard. Owner—United States.

Engines: Type....four-cylinder, triple-expansion
Cylinder, diam.....32 1-2, 53, 61, 61 ins.
" stroke.....48 "
I. H. P., designed.....16,500
Revolutions, designed.....120
Cylinder walls, thickness H. P. ....1 7-8 ins.
" " I. P.....1 7-16 "
" " L. P.....1 1-4 "
Piston rods, outside diam.....7 1-4 "
Connecting rods,
Length between centers.....96 "
Diam. top.....6 7-8 "
" bottom.....8 "
Piston valves, diam. H. P.....17 1-2 "
" " two I. P. and two L. P..19 "
Shafting, diam. crank.....16 1-2 ins.
Diam. crank pins,
17 1-2 by 19 ins. long
" thrust..15 1-2 and 15 3-4 ins.

Shafting, diam. line.....15 1-2 ins.
" stern tube and propeller.....16 1-2 "
" axial hole in all.....9 1-2 "
Air pumps.....two 30 in. steam,
two 12 1-2 air by 20 in. stroke
Condensers, cooling surf., each 10,375 sq. ft.
Tubes.....4,878 tubes 18 B. W. G. 5-8 in. o. d.
Circulating pump.....265 revolutions,
12,000 gal. per minute
Boilers: Number of.....12
Type.....Babcock and Wilcox
H. S. total.....46,750 sq. ft.
G. S. total.....1,100 "
Working pressure.....265 lbs.
Length of grate.....6 ft. 9 ins.
H. S. + G. S.....42.5
H. S. ÷ I. H. P.....2.83
I. H. P. + G. S.....15.0

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NEW UNITED STATES BATTLESHIP CONNECTICUT AND CLASS.

Length on load water line, 450 ft.; Beam, extreme, 76 ft. 10 in.; Draft, mean, 24 ft. 6 in.; Displacement, 16,000 tons; Speed, 18 knots; Indicated horse power, 16,500. Batteries: Main, four 12-in. B.L.R., eight 8-in. B.L.R., twelve 7-in. B.L.R.; Secondary, twenty 3-in. R.F., twelve 3-pdr., eight 1-pdr., two 3-in. field, eight machine.

Armor: Belt, top 11 to 4 in., bottom 9 to 4 in.; Turrets, 12, 8, and 6 ins.; Barbettes, 10, 6, and 4 ins.

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pipes connecting near the top and bottom of the low-pressure chests.

The high-pressure piston and followers are of cast-iron; the other pistons will be of cast-steel with wrought-iron followers. The design of these parts is shown in the drawing. The piston rods are hollow, with a 4 3-8-inch hole in the low-pressure rods, a 3-inch hole in the intermediate, and 1 1-2 inch in the high pressure. These holes are reduced at the crosshead ends. The outside diameter of all rods is 7 1-4 inches. The crosshead pins are to be 9 1-2 inches diameter. The forged-steel crosshead is of the slipper type, with bearing surface faced with white metal, and 21 by 27 inches on the go-ahead side. The connecting rods are also hollow, the bores being of different diameters, and they are forked at the upper end for spanning the crosshead; brasses are accurately fitted at either end, lined with white metal. The piston valves are single-ported and fitted with cast-iron packing rings and forged-steel followers. Each valve is fitted with a balance piston. The eccentrics are made in two parts, the larger part being of cast-iron, the smaller of forged-steel, and both will be rabbetted at each side for flanges of the eccentric straps. The backing eccentrics will be securely keyed to the shaft and each go-ahead eccentric will be fitted with a key and adjusting piece. The straps will be of composition and in two parts. The valve stems and eccentric rods are of high-grade forgings.

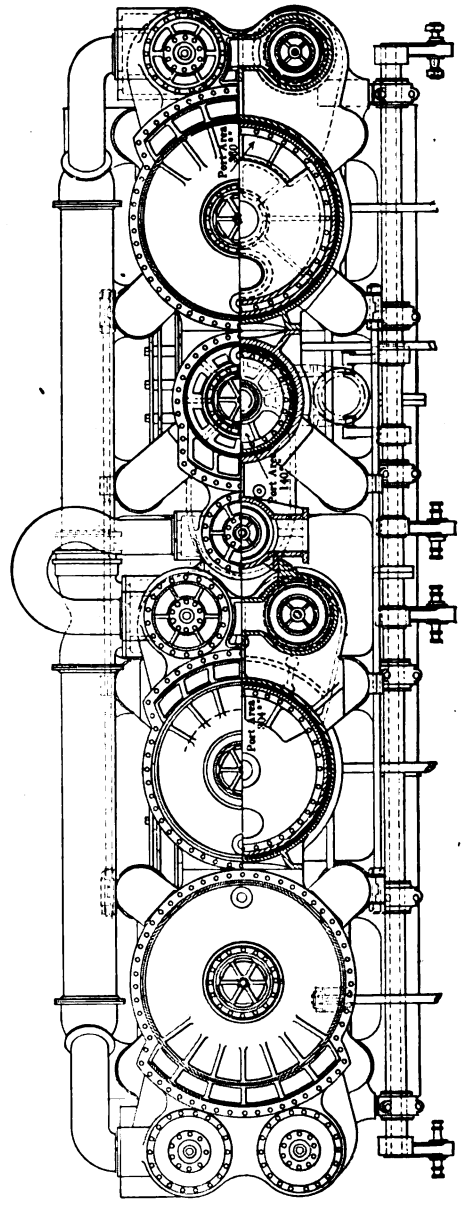
The cylinders for each engine will be supported by 6 front and 6 back columns, 5 1-2 inches diameter, of design as shown in the drawing, and with suitable diagonal braces. The crosshead guides will be of cast-iron, with water circulation, and the slipper backing guides will be of cast-steel properly secured. The bed plate is of cast-steel, with longitudinal and cross girders of I section. All shafting is of "Class A" forging, with an axial hole bored from end to end; the diameters are given in the accompanying table. The crank shaft will be in two sections, coupled together; the thrust shafts have thirteen collars; the stern tube shafts will be covered by composition water-tight casting made in sections, shrunk and pinned on; a casing will also be fitted to the propeller shaft. The screw propellers are to be of manganese bronze, left-handed on the starboard engine and right-handed on the port engine. The reversing gear for each engine will consist of a steam cylinder and an oil-controlling cylinder secured to the high-pressure cylinder casing. The reversing shafts are carried along the inboard side of each engine, with bearings secured to the engine column and low-pressure valve chests. The floors on the inboard side of each engine, opposite the high and intermediate cylinders, will serve as working platforms. A very complete system of lubrication is specified, both automatic and sight-feed lubricators being used.

Names of Masts.—In view of the discussion as to the names of the masts of six- and seven-masted schooners, the captains of these vessels have agreed to name the masts as follows: The first three masts will be called by the names that have always been applied to them, namely, fore, main, and mizzen, and the aftermost mast shall be called the spanker. When there are more than four masts the names of the intervening masts will be termed No. 4, No. 5, No. 6, etc., numbered from the bow.

German Shipbuilding.

The United States Consular Reports for March contain an interesting sketch of the progress of shipbuilding on the river Weser in Germany. The first of the record-breaking ships turned out by Germany was the *Kaiser Wilhelm der Grosse*, which was followed by the *Deutschland* in 1900, the *Kronprinz* in 1901, and the *Kaiser Wilhelm II.*, now about to make her maiden trip across the Atlantic. Thirty years ago there were only seven shipyards in Germany; to-day there are about sixty, large and small. Five of these are located on the banks of the river Weser between Bremen and Bremerhaven. While they are not equal to building the largest types of merchant and war vessels, they are fully equipped for turning out thoroughly modern vessels of every description. All these concerns are doing prosperous business and paying dividends of between 10 and 12 per cent.

The Weser Aktiengesellschaft is now building new yards covering about six acres of land. The Vulcan



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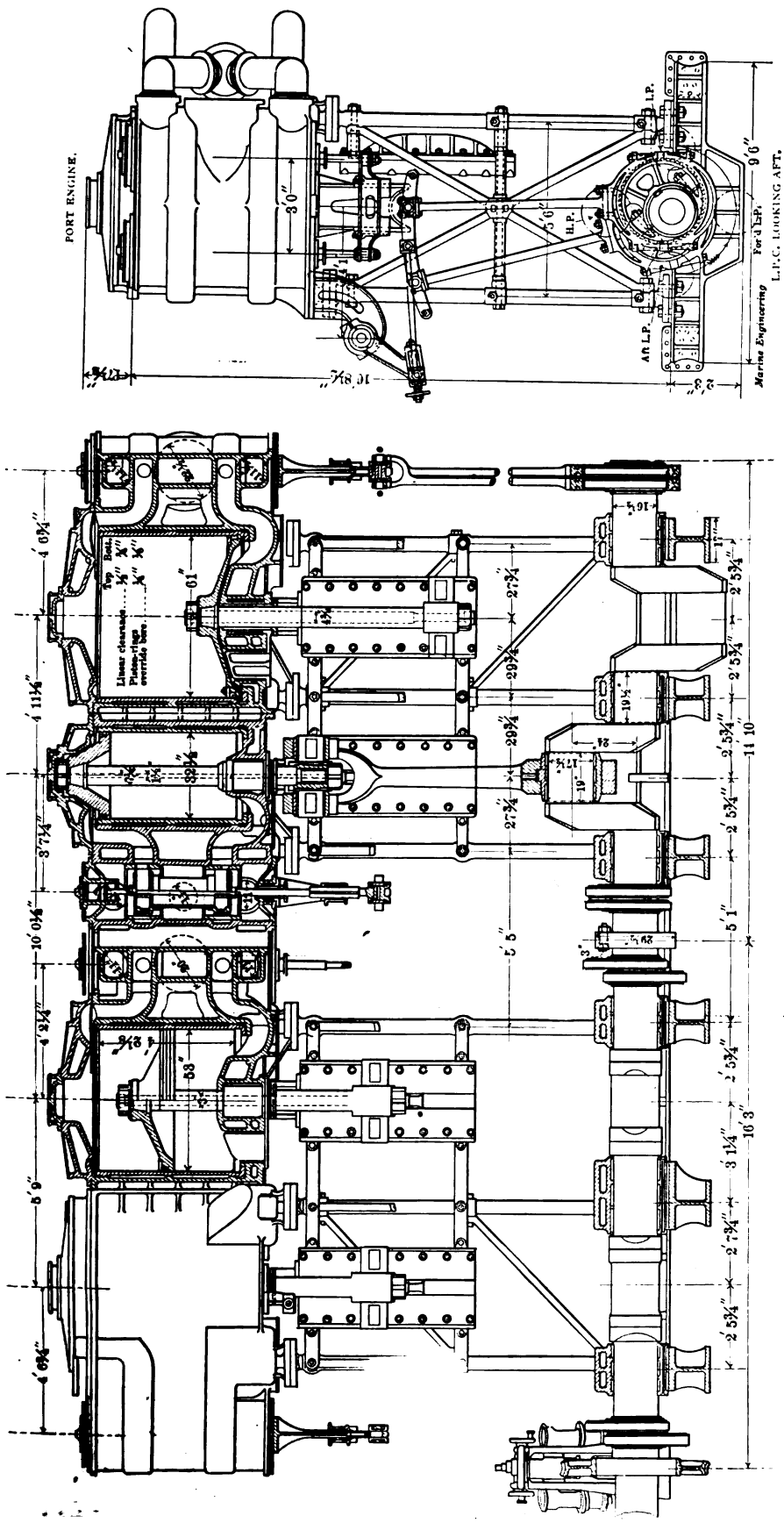

FOUR-CYLINDER TRIPLE-EXPANSION ENGINES OF THE NEW BATTLESHIPS CONNECTICUT AND LOUISIANA.

Shipbuilding Company has a modern plant, and, while it cannot build the large ships which are turned out of the Stettin yard of the same name, it has launched six ships during the last six months and has seventeen others under construction. The Tecklanburg Company, at Bremerhaven, has been occupied to its fullest capacity during the entire year, having under construction six twin-screw freight and passenger steamers and two large sailing vessels. This firm is famous for building large sailing craft; the largest in the world, the *Preussen*, was completed a few weeks ago. This company declared a dividend of 20 per cent. at the close of its last business year. The Rickmers Rhederei and Schiffbau Company, at Bremerhaven, has three small steamers under construction. The G. Seebeck Company, Bremerhaven, declared a dividend of 10 per cent. upon the closing of its seventh business year. The chief output of the yard has been in steamers for fishing on the high seas. Two passenger and freight steamers were also built for the North German Lloyd Company, making a total of 192 ships turned out since its foundation.

Thus it is seen that Germany, while undergoing depression in many commercial lines, has been very active in shipbuilding. This is specially noteworthy, as Germany is not geographically a strictly maritime nation and is dependent on other countries for the raw materials that enter largely into the making of the ship.

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FURTHER NOTES ON THE INFLUENCE OF SHOAL WATER UPON THE SPEED OF SHIPS.

BY ALFRED E. LÜDERS.

The purpose of this article is to draw attention to a few experiments, made by various people, that bear out, more or less, the conclusion to be formed from a study of Captain Rasmussen's investigations as set forth in the November number of MARINE ENGINEERING.

The experiments, aside from the deductions to be made from them regarding the influence of shoal water upon speed of vessels, are in themselves of interest on account of the unique manner in which the investigators conducted the trials in an effort to get at the fundamental principles underlying the subject. The experiments in question and the subsequent discussions are to be found set forth at some length in various papers of the British Institute of Naval Architects.

The following remarks are taken to some extent from these papers, and back numbers of other publications were freely consulted in an endeavor to exhaust the subject as nearly as possible.

In 1900 Major Rota, R. I. N., conducted a series of model experiments in the model tank at the Royal Dockyard of Spezia, Italy. In these trials the tank, which ordinarily had a depth of ten feet of water, was shoaled by means of an adjustable wooden flooring extending a considerable length of the tank, and by the simple expedient of raising or lowering this platform the depth of water could be regulated to suit.

In all, five models were tested, the resistance, trim, speed, etc., being tabulated in the usual manner at the various depths of water. From these data it was possible to apply the results to full-size ships by the well-known laws of comparison.

The figures obtained by the trials of models were put in the usual form of speed and resistance curves, the curves for the various depths being superimposed to facilitate comparison. In Fig. 1 model No. 5 is shown, as this is the only boat that was speeded at an abnormal rate for the various depths of water; here the curves show the characteristic hump at what we have termed the "critical speed." It will be noticed how, in the case of extremely shallow water, the resistance falls below the normal resistance curve when the vessel is pushed beyond the "critical speed."

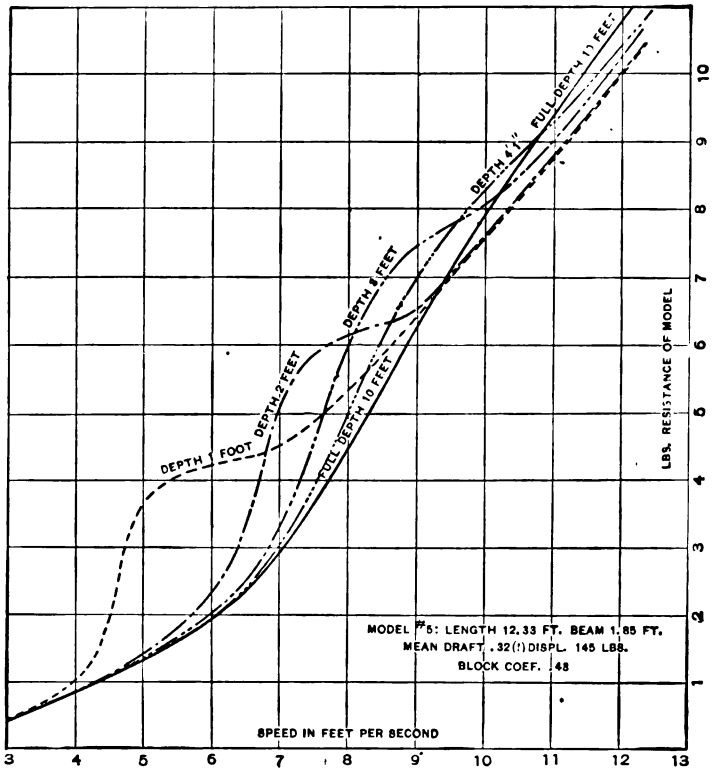

FIG. 1.—RESISTANCE AND SPEED CURVES OF MODEL 5, IN DIFFERENT DEPTHS OF WATER.

These curves appeared, in Major Rota's paper, in the metric system, and have been, for the sake of convenience, adjusted to conform to the foot and pounds standard. In the trials just referred to, the idea was not to determine the critical speed, but rather to find a maximum speed, at the various depths, at which resistance would be at a minimum.

In Fig. 2, which is a set of cross curves of Fig. 1, the locus of minimum resistance is shown, and from that Major Rota calculated that for the following speeds, for a 150-ton torpedo boat on the lines of model No. 5, it would take the following depths of water:

Speed in knots per Hour.	Depth of Water in Feet, Corresponding to Minimum Resistance.
12	43
14	53
16	76
18	85
20	85
22	20 (about)
24	20 "
26	20 "
28	20 "
30	20 "

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The decrease of resistance at high speed is attributed by this writer to variation of trim, which is sensibly different from that observed in deep water.

In the discussion that followed the reading of Major Rota's paper, it was brought out that Mr. Archibald Denny had had recourse to model experiments in his tank at Dumbarton, with the idea of ascertaining whether or not his firm could guarantee certain speeds in shallow rivers. His conclusions were that they certainly would not do so. As an explanation for holding such opinions, he laid considerable stress upon the instability of the results of the trials; runs taken within five minutes of each other showed variations of as much as 15 per cent. resistance for the same speeds.

The water in the tank was only 1.252 feet deep during the shallow-water trials, a false flooring having been fitted for about 150 feet, in much the same manner as had been done by Major Rota. When the model was towed at extreme speeds, the flooring of tank was laid bare of water for some distance behind model; the consequent change of trim is apparent from the curves. As a check on the formula:

$$V^2 = gh,$$

where V = speed of vessel in feet per second,
g = acceleration due to gravity, or 32.16,
h = depth of water at which speed is critical.

If we take the case of Mr. Denny's 12-foot model, then from the curves we see that

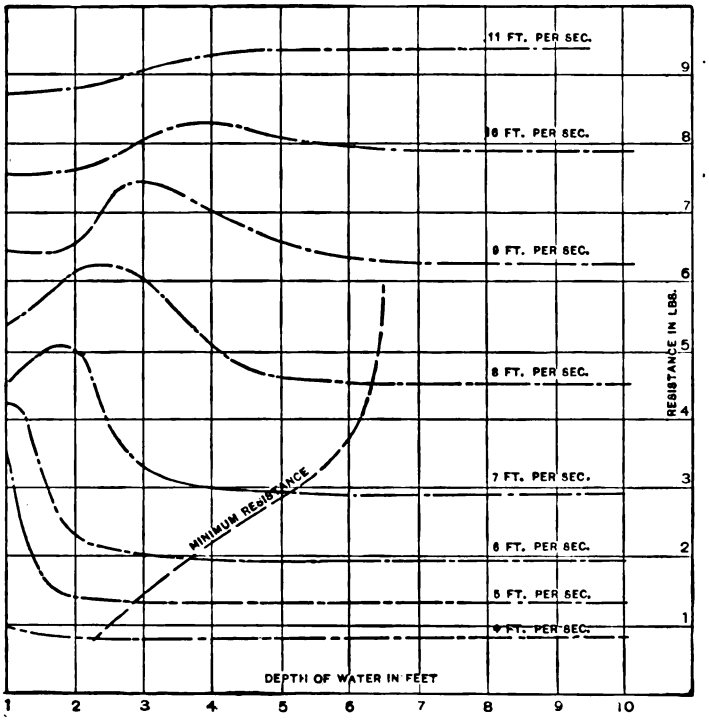

FIG. 2.—RESISTANCE AND SPEED CURVES OF MODEL AT DIFFERENT SPEEDS.

In the experiments on the Danish vessels Captain Rasmussen also spoke of this instability; he noticed that when the ship was running at speeds close to the value $V = \sqrt{gh}$, the putting of the helm over was sufficient to cause a drop of several knots in the vessel's speed; quite some time being required before the vessel reached the speed V after helm had been brought amidships.

To return to Mr. Denny's investigation, the vessel for which the speed guarantee had been requested was a barge 200 feet long by 27 feet beam. The model corresponding to this ship was 12 feet long, 1.62 feet beam, .27 foot draft, and had a block coefficient of .837. By referring to Fig. 3, we see the speed, resistance, and trim curves plotted; the shaded portion between the two curves is the difference in two similar trials and represents graphically the above-mentioned instability. Here again we have an example of the resistance in shallow water being less after critical speed had been passed than that met with in greater depths.

$$V = \frac{380}{60} = 6.33 \text{ feet per second.}$$

By substituting and solving for h we have

$$h = \frac{(6.33)^2}{32.16} = 1.246 \text{ feet,}$$

which is .006 foot less than the actual depth of water in tank.

From the various trials that have been conducted, it is obvious that we can ascertain the resistance of a vessel driven at speeds far beyond the critical speed, from which it is only natural to suppose that put sufficient power in the ship and the desired speed will be reached. This is quite true in general, as stated in the earlier article; but as abnormal speeds beget abnormal conditions, we might find that in the case of a paddle steamer the wheels would have to work alternately in the hollow or on the crest of the wave as the speed fluctuates, while in a screw vessel the water might disappear entirely from under the stern; propulsion under such circumstances would be manifestly impossible.

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As practical examples of the effect of shoal water upon the speed of vessels, the following are cited:

The British Admiralty tested two torpedo gunboats of exactly the same design; one was tried at half and the other at low tide, the corresponding depths being respectively 51 and 42 feet. The same power was developed in each boat, but the vessel that was tried in deep water attained a speed of 17 1-2 knots, while the other boat made a half knot less in the shallower water.

Another vessel of same type, which had trials at both high and low water, averaged over the high-water run 17.8 knots with 2,800 I. H. P., whereas during low water 16.9 knots were obtained with an expenditure of 2,600 I. H. P.; here the loss due to shoal water was a half knot, after allowing for the difference in power.

The *Edgar*, a British twin-screw, first-class cruiser, 7,350 tons displacement, in 12 fathoms of water required 13,260 I. H. P. to make 20 1-4 knots, while in 30 fathoms 21 knots were reached with 12,550 I. H. P., a gain of three-quarters of a knot with 710 less horse power; in other words, the *Edgar* would attain 20 1-4 knots with 1,500 I. H. P. less than that required in the shoal water.

The *Columbia*, a twin-screw transatlantic vessel of the Hamburg-American line, during her trial in 8 fathoms of water, made 19 1-4 knots, while in her regular passage 19 knots are averaged, 19.5 knots being frequently reached.

The above cases, although by no means extreme, all point out the necessity of having sufficient depth of water to avoid approach to the critical speed and thereby incurring undue resistance.

Mr. Froude has noted some experiments taken quite a number of years ago, in which it was found that the shoaling of the water increased the resistance only from 3 to 5 per cent. This was deduced from model experiments in the tank at Torquay, the models, however, being run at a comparatively moderate speed, 16 knots being about the limit for vessels at that time.

A rather interesting feature in the case of vessels going at high speed, where the water is limited in depth, is the tendency of the vessel to sink bodily. In one instance the decrease of freeboard was very noticeable when the ship was speeding, but it was thought to be an optical illusion until careful measurements were made and the actual decrease of freeboard was established as a fact. The boat in question was employed as a scout.

Stern-wheel steamers often ground when under way in water that is of ample depth for vessels when at rest. To get around this difficulty when this type of vessel finds it necessary to go over shallows in a river, it frequently has recourse to backing through them, and thus avoids grounding. The explanation of this is very simple: when going ahead in the ordinary manner, the stern wheel accelerates the flow of water from under the after end of vessel, there is a loss of buoyancy and the stern sinks enough to touch bottom; when the vessel is turned and backed the wheel again accelerates the flow of water, but this time it is forced under the boat, buoyancy being thereby gained, and the vessel floats high enough to obviate all danger of grounding.

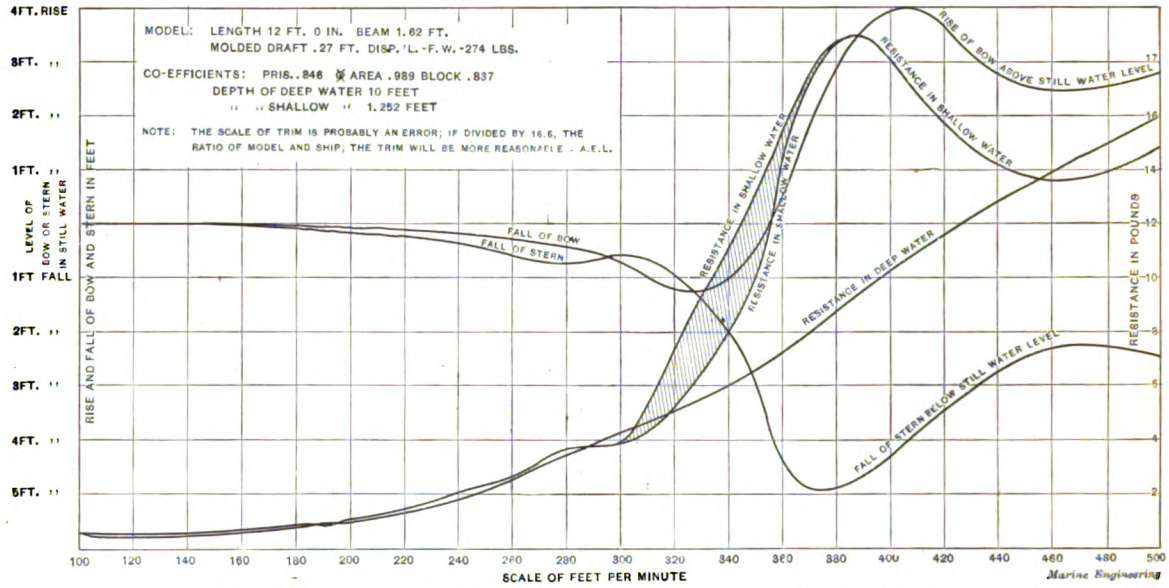

FIG. 3.—COMPARISON OF RESISTANCE IN SHALLOW AND DEEP WATER OF A BARGE 200 FEET LONG, 27 FEET BEAM, AS OBTAINED BY MODEL EXPERIMENT.

As a concluding example to the general phenomena, and one that may prove of interest to launch owners, attention is drawn to the Thames launch *Boadicea*, a Thornycroft boat of approximately 35 feet length, 5 feet 6 inches beam, and a draft of 10 inches; this boat was fitted with a turbine propeller 16 inches in diameter working in a tunnel at stern of boat. This craft, which had a speed of 15.8 miles per hour, has the distinction of running more swiftly and easily when crossing the mud flats at low tide, with only an inch or two under her bottom, than when in the deep channel. Here we see that for a probable depth of, say, 1 foot of water the vessel is at the critical speed when making about 3 1-3 miles per hour, so it is only reasonable to expect that when the speed of 15 miles per hour is approached the resistance should be considerably less than met with in deep water. This proves conclusively the possibility of high speed in shoal water.

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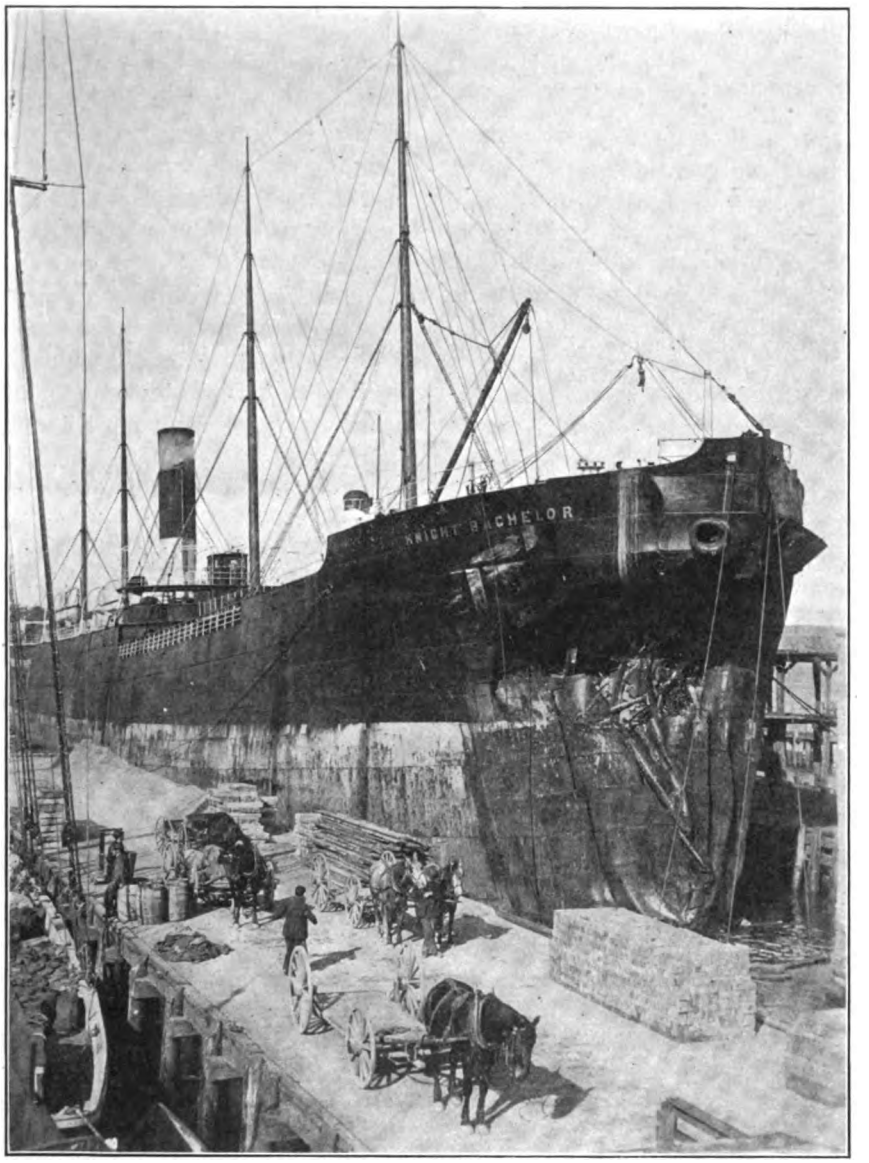
Bad Head-On Collision.

The accompanying illustration of the new, fine English ship *Knight Bachelor* shows how badly her bows were broken in by colliding with an iceberg off the banks of Newfoundland several months ago. Navigation of these waters is extremely dangerous in the spring because of the floating ice and icebergs. To add to the dangers are the banks of fog which hover over these waters for half the days of the year. Fog is almost always present in the neighborhood of icebergs, thus increasing the risk of collision.

Fortunately, the *Knight Bachelor* sustained the greatest damage above the water line and was kept afloat by the presence of the forward collision bulkhead. She proceeded under her own steam to Halifax, where repairs have since been made. The ship is 450 feet long, 52 feet beam, 31 feet deep, and is of 6,394 gross tons. She was built at Glasgow in 1894.



STEAMER KNIGHT BACHELOR AFTER COLLIDING WITH AN ICEBERG.

Reorganization of the William R. Trigg Company.

A prospectus of the reorganization plan of the William R. Trigg Company has been distributed to stockholders and creditors of the company. The reorganization is being undertaken by Joseph H. Hoadley, of New York, N. Y., in accordance with the recommendation of the Reorganization Committee. The creditors are to receive in settlement of their claims, not including interest, 33 1-3 per cent. in cash and the balance, or 66 2-3 per cent., in the common stock of the new company. The second mortgage of $1,000,000, the issue of $755,000 preferred stock, and $1,155,000 of common stock, are to be exchanged for the new securities. The new corporation will have a capital of $1,500,000 6 per cent. accumulative preferred stock with shares at par value $1,000 each, and $5,000,000 common stock with shares at par value $100 each. The company may also issue $1,000,000 worth of thirty-year 4 per cent. gold bonds.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

If the last Congress failed to meet our expectations in some directions, it spoke in no uncertain terms at least regarding the continued upbuilding of the navy. Five new battleships are provided for, three of which will undoubtedly be duplicates of the *Connecticut* and *Louisiana*, of 16,000 tons each, our heaviest and largest ships yet designed or contemplated. The other two are to be of about 13,000 tons each, a size intermediate between the new *Maine* and class and the *Virginia* and class. There should be no delay in making a start on the three larger ships, at least. The plans of the *Connecticut* and *Louisiana* are immediately available, and such minor changes as may be considered necessary should only take a few weeks' time. The plans will certainly be changed in minor ways during the progress of construction, and no better start could probably be made than to take the plans for this class substantially as they are and proceed with the call for bids. If there is one thing about our naval construction regarding which we cannot take pride, it is the length of time required by our yards between the signing of the contract and the delivery of the completed ship. Measured in years, as it is, it seems impossible to understand where all the time can have gone, or how possibly such a period can have been necessary for the preparation and assembling of the few thousand tons of material which constitute even a battleship.

Looked at in detail, and with the builders' statements regarding delays from all manner of causes —lack of material, lack of armor, lack of equipment and failure on the part of various subcontractors for auxiliaries and equipment to deliver as agreed, changes in the plans, excessively rigid inspection, labor troubles, etc., etc.—one can see where at least a part of the time has gone. Giving the builder full benefit for these various causes of delay, it still remains a fact that the time seems too long. Without attempting, however, any apportionment of the responsibility for delays or for the length of time required, it is very sure that it is too long, and no one feature of our naval construction is perhaps more deserving of careful study from both the engineering and the business point of view. All shipbuilders realize that the saving of time is a matter depending on one quite as much as on the other.

In a word, here is the situation. A given ship requires, let us say, 8,000 tons of structural material to be prepared and assembled. The actual work drags over two or three years or more. The time really occupied in the work that finally counts, and reduced to the basis of full gangs of workmen constantly employed, is probably not much, if any, over half this. In other words, there is no mechanical hindrance to the building of the ship in perhaps half the time actually required. Then why not do it, or, at least, make some nearer approach to such a rate of construction?

The answer involves the whole situation, technical and business, and in recent years has attracted the attention of some of our ablest Naval Constructors on the one hand, and of our most experienced and capable shipbuilders and engineers on the other. We shall attempt to offer here only two or three suggestions, perhaps self-evident in themselves, but, nevertheless, not always appreciated at their full importance.

In the first place, there should be the clearest possible understanding between the buyer and the builder as to just what is to be furnished by the latter, and, once the contract made, the presumption should be decidedly against any change. It is not to be assumed, of course, that no changes should be made where marked improvement can clearly be effected, but the burden of proof should

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be clearly on the side proposing the change, with the presumption against it. It will be better to get the ship somewhere nearly on time rather than have her completion delayed for changes of uncertain value. Again, in all government specifications the phrases "as approved," or "of approved design," are fruitful sources of possible delay. It is not always possible in advance to specify the exact make or quality of each item of equipment, or of certain structural arrangements dependent on special equipment, and some such phrase seems a practical necessity. Here again, in drawing specifications, the presumption should always be against such a phrase, unless absolutely necessary. If so, the agreement involved should be made at the earliest possible moment, and long in advance of the period of use of the item concerned, so that no delay may be caused when the time of installation is at hand. Perhaps the most serious delays are caused by the difficulty in obtaining structural material promptly, especially when the shapes and dimensions are somewhat unusual, as may frequently occur in government work. Here something might, perhaps, be done by a more careful scrutiny of the scantlings involved, by an elimination of odd or unusual sizes and shapes, and by a more pronounced attempt to meet the trade condition as viewed by the steel maker in his efforts to keep up with his orders. Here the builder meets with the difficulty which affects all his construction, mercantile as well as naval. It is a difficulty the more serious in that its removal lies, in great measure, outside his power. Probably the most that the shipbuilder can do seems to be to anticipate his needs to the furthest possible extent, and to use all his powers of persuasion with the maker to give him his material on time and, to some extent at least, in the order desired. In the shipyard itself the question of speed depends on too many factors to admit of any discussion in detail whatever. Generally speaking, however, and having interest charges, insurance, etc., in view, it will be found cheaper in the end for the builder, as well as better for the government, to operate all the men who can profitably be employed on the material and without blocking each other's way. In other words, the effort should be made to so lay out and arrange the work as to admit of the maximum number of points of attack at one time, and to follow up the work in this manner by the employment of a man wherever a point of attack is open. In the shops, likewise, the ideal should be to keep every wheel turning and every tool in operation throughout the largest possible fraction of the day. An idle tool is earning nothing, and, on the contrary, is, through its fixed charges, a source of constant expense. Special tools cannot be kept so occupied, but by suitable study something could usually be done to increase the rate of output by keeping standard tools, such as punches and shears, busy in one way or another for the maximum possible number of hours per day. In other words, the presumption should always be against an idle tool; it should require an excuse and a good one.

The importance of effecting a marked increase of constructive speed in our shipyards, and especially in government work, can scarcely be exaggerated, and the accomplishment of such an end is certainly worthy of the most painstaking study and effort on the part of all parties concerned. Such study, with a spirit of co-operation, actuated by a common desire to attain this end, would certainly accomplish much. Is it not worth renewed and most serious attention on the part of both government and private builder?

INTEREST in the water-tube boiler question is still active. In Great Britain the "Boiler Committee" is occupied in further experiments, of which we learn the results from an occasional Parliamentary paper or from the public press. The latest paper deals with experiments carried out at various times in 1901 and 1902, and chiefly on boilers of the Niclausse and Babcock and Wilcox types. The results show marked improvement between the earlier and later types of these boilers, especially in the case of the latter. Difference in the conditions makes a comparison between the two types difficult. In the United States we are engaged in the navy in accumulating still further evidence regarding the various types, the results of which are published in full in the successive numbers of the *Journal of the Society of Naval Engineers.* The last issue, recently to hand, contains articles on the performance of the Babcock and Wilcox boilers of the *Marietta;* on the contract trials of the monitors *Wyoming* and *Nevada,* the former fitted with Babcock and Wilcox boilers, and the latter with Niclausse; on the contract trials of the destroyer *Stewart,* fitted with Seabury boilers, and a valuable general discussion of the "Naval Boiler Problem." We would commend these articles to all who are interested in the study of this problem from the modern standpoint of actual trial and experience.

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United States Rules for Boilers.

Editor Marine Engineering:

It is a very easy matter for some people to find fault, then stop and not point out the remedy. It is also easy to misrepresent fact, not always done intentionally, perhaps, but sometimes thoughtlessly or on hearsay evidence. Therefore I must take issue with your correspondent "H. L. E." in his communication printed on page 159 of your March number (entitled "United States Rules for Boilers") regarding the Board of Supervising Inspectors' revival of an old rule, referred to by him as a "dead-letter law (Sec. 5, Page 22)," viz.: "Where flat surfaces exist, the inspector must satisfy himself that the spacing and distance apart of the bracing and all other parts of the boiler are so arranged that all will be of not less strength than the shell."

I have not looked up the matter far enough back to be able to state when it was first adopted or incorporated in the rules, but I find it is required by Sec. 4433 United States Revised Statutes. I also find it in the Rules and Regulations as far back as those issued in 1883, and I fail to find that it has ever been repealed. It is printed in every copy in my possession, and I have them for almost every year since the date mentioned. It will also be found in last paragraph of Sec. 6, page 25, of Rules and Regulations of 1902. I wish, therefore, H. L. E. would inform me when it was repealed and when revived.

It is a well-known fact among engineers, boilermakers, and others that there must be some established basis for the strength of a boiler. On general safe principles, then, all other parts and elements must conform in strength to that basis, and I am unable to see the force of his objection to the rule, unless he wants to make the seam the basis of calculation in place of the shell. If such is the case, what is to be gained? Just one of two things—either a greater factor of safety in the seam or a slightly reduced thickness in the shell, because all other parts of the structure must of necessity remain the same for the stated pressure. Practically the same object can be attained by adding to the present rule a minimum strength for the seam. If, for a given thickness, the factor of safety is to remain the same, and the allowable pressure increased according to strength of seam, then furnaces, staying, and all other parts must conform in strength to the increased pressure so allowed. This will add to the weight and cost quite as much as in the case cited by him, when analyzed and brought down to fact. His comparison is made by criticising a former reply in your January number, where the question and conditions were widely different from usual practice, and comparing it with United States rules, viz.: A boiler 12 feet diameter, material 60,000 T. S., strength of joint 80 per cent., factor of safety 4 1-2 with 1-16 inch added for corrosion.

He says: "Therefore in Q. 120, if a boiler 12 feet diameter, 60,000 T. S., and double-riveted, be given a shell 1 1-16 inch thick, the calculation by U. S. rules will give 177 pounds as the working pressure; and furnaces, stays, and all other parts will have to be designed for 177 pounds, even if it is desired to carry only 150 pounds working pressure. Of course the increase in size and weight will increase cost." Again: "U. S. rules for double riveting practically makes 5 the factor of safety in this case, and the shell thickness would then figure only 0.9 inch, omitting the 1-16 inch added for corrosion. The addition for corrosion will, according to U. S. rules, incur a *severe penalty*," etc.

In reply to this criticism, the calculations of H. L. E. for allowable pressure on the thicknesses of plate cited are correct, but the figures are misleading, inasmuch as he quotes 1.0625 inch thick in the case of the boiler having 1-16 inch added for corrosion, and leaves the 1-16 inch off in the other case. And again, he cannot obtain 80 per cent. strength of seam with double riveting in 1 1-6-inch plate. Hence the joint must be butt-strapped and triple-riveted.

Referring to a boiler of the dimensions stated and for 150 pounds working pressure, under U. S. rules the *severe penalty* alluded to by him for adding 1-16 to 0.9 inch will amount to just 10 pounds per square inch, making for a boiler .9625 inch thick 160 pounds working pressure. Hence the furnaces, staying, and all other parts of the structure would only have to conform to that of 160 pounds. This extra 10 pounds over the required pressure of 150 will not add very much to weight and cost; and if the person having it built desires a larger factor of safety than the rules require, he should have it in all the elements of the structure.

Under present practice multiple-riveted seams are not acceptable under 70 per cent. in any and all of their elements. In such case, then, by present rule, the factor of safety is 3 1-2 on the seam. If we are to consider the joint at 80 per cent., then the factor of safety is 4 for the joint, but all other parts will remain the same and have the same relation to the shell as before; hence no extra weight or cost. On the other hand, if the factor of safety remains 3 1-2, based on strength of seam, the allowable pressure will be increased to 171 pounds, and all other parts must also be increased in like ratio, adding to both weight and cost. Of these two conditions, I prefer the extra strength of seam.

For good tight work under high pressures, double-riveted lap joints are seldom over 72 per cent. Where double butt straps and triple-riveted joints are made in heavy plate, with the two inside rows of rivets in single pitch and double shear, and the outside row in double pitch and single shear, it is quite practicable to obtain 80 and even 86 per cent. for the joint. To this extra factor of safety on heavy plate, with the high pressures of steam of present-day practice, I can see no objection. Percentage strength of seam, if obtained with so great a pitch as to allow of leaky joints, must be avoided.

The requirements for seams of marine boilers are that all rivet holes shall be drilled. The shell is made the measure of strength for all other parts, and with a longitudinal seam having a minimum strength of 70 per cent. the factor of safety is 3 1-2 on the seam. Its strength may be increased by multiple riveting, but this does not in any way change the conditions or requirements regarding other parts of the structure; hence the rule is a simple one. R. C.

Shamrock III.—As an omen of good luck, Sir Thomas Lipton's third challenger for the America's Cup was launched on St. Patrick's day, March 17, from the yards of Messrs. Denny Brothers, Dumbarton, Scotland.

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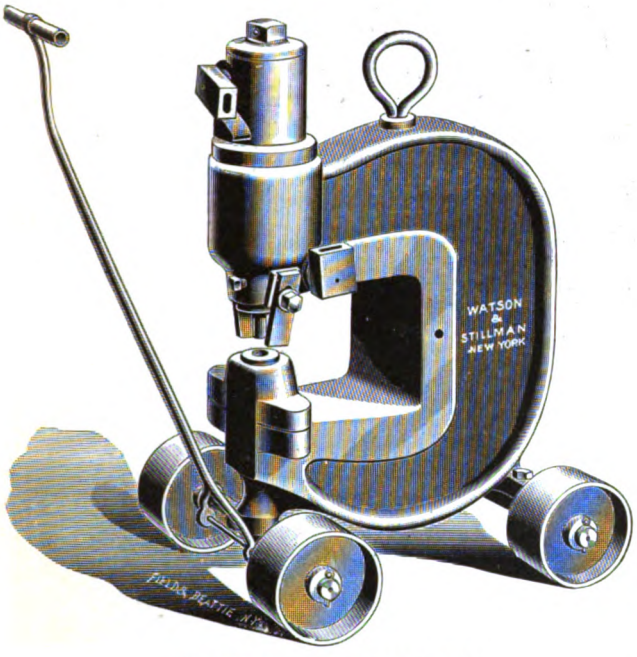
ENGINEERING SPECIALTIES.

Portable Hydraulic Punch.

The accompanying cut illustrates a portable beam punch operated by hydraulic pressure which is found to be a most convenient tool in shipyards, as it is mounted on wheels and can be drawn to the work. The punch is operated by a pump worked by a lever inserted in the socket shown on the left side of the head. The parts are of easy access for examination and repair, and the head may be turned to receive the lever from any position, so that the operator may stand in any convenient place. The bed is of steel. One motion of the lever in the lower socket withdraws the punch entirely from the machine or brings the punch down on the



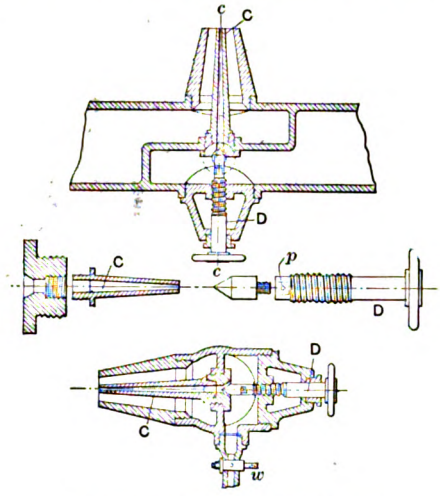
PORTABLE HYDRAULIC BEAM PUNCH.

work without the labor and the loss of time necessary to pump it down. As the punch is prevented from turning, irregular-shaped dies may be used without the danger of the punch cutting down on the die. The machine is made in two sizes, with a 9-inch and a 12 1-2-inch throat, and the design of the jaw permits a beam to be punched close to the flange. The tool may be lifted by the hand ring at the top. This machine is built by the Watson and Stillman Company, 204 East Forty-fifth street, New York, N. Y.

Liquid Fuel Burner.

The oil burner, of which the following is a description, claims as an improvement the method of fastening the parts subject to wear so that they may be easily removed. The illustration shows a horizontal sectional view at the top, a sectional view through line *cc* at the bottom, and detail views of the oil valve and nozzle. On the sectional views there are the valve, *D*, and the nozzle, *C*. The exterior nozzle is the steam or compressed-air nozzle, and it is screwed into the pressure pipe as shown. The oil nozzle is screwed into a hardened bushing, which is itself screwed into the partition which separates the oil and steam passages. This bushing is the part which is most apt to wear, and its method of fastening, as described above, is plainly seen from the drawings.

The back of this bushing also forms the conical seat for the needle valve, and the end of this valve is in the form of a removable conical plug, which can be fastened to the valve stem by screwing it in or holding it in with a pin, as shown at *p* in the enlarged view of the valve stem. It is thus seen that the two parts of the burner most liable to wear, namely, the valve seat and



NEW STYLE OF LIQUID-FUEL BURNER.

plug, are made and fastened in such a way as to be easily and cheaply renewed. A cock, *w*, placed as shown in the lower sectional view, allows the heavy impurities of the oil, which collect at this point when the burner is not in use, to be drained off before lighting.

The burner has a great variety of uses. Three burners will be equivalent to about 25 square feet of grate under a marine boiler. They may be attached to all kinds of furnaces for melting metals and are also used with good results on annealing furnaces, grate- and angle-bending furnaces, etc. The burner is portable and can be taken on board ship for use in repairing bent or fractured plates. It is also well adapted to rivet forges and for heating small and large billets used for drop forgings.

For further particulars concerning this patent burner address James Moran, 47 Horatio street, New York, N. Y.

Eighteen-inch Engine Lathe.

An 18-inch lathe has been put on the market by the American Tool Works Company, Cincinnati, Ohio, which embodies in its design the greatest producing capacity with the requisite quality of workmanship in the machine itself and accuracy of its product. This is considered by the makers to determine the true value of the lathe.

The lathe has a range of forty-four changes of thread and the same number of changes of feed, obtainable in about thirty seconds without removing a single gear. It

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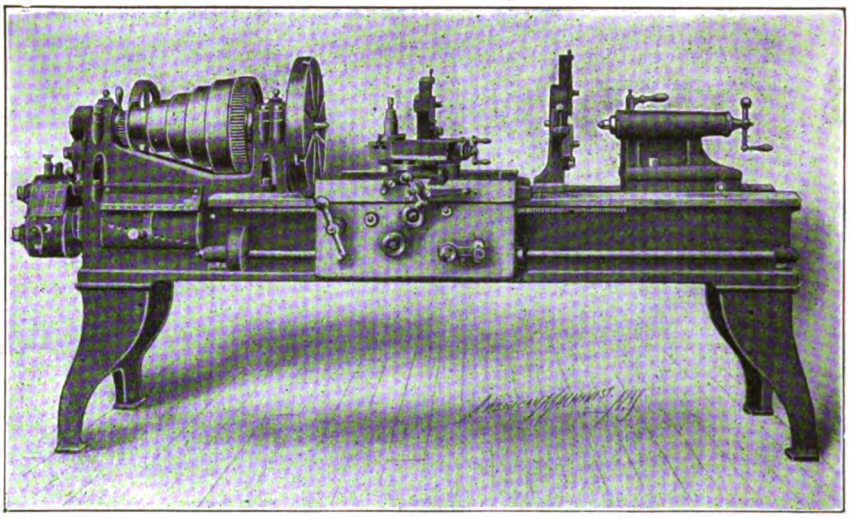
will withstand the heavy duty now imposed upon tools due to the introduction of tool steels adapted to high speeds. Gears have been made of steel wherever it has been found there is special wear, and all parts are made sufficiently strong to place the limit of the feed at the belt and not in the apron or gear box. The feeds are positive, and ratio between the longitudinal and transverse feeds is even. All jigged parts are interchangeable. The workmanship and finish are as good as obtainable with the best of tools, and every machine is tested before leaving the shop.



AN 18-INCH ENGINE LATHE.

The bed is a box girder with a patent drop-V pattern, giving an additional swing of about 2 1-2 inches. The webs are tied together with girths of box form, making the bed very strong indeed. The head stock is massive and symmetrical, and the cone has five steps for the wide belt. In connection with the back gears. ten changes of speed are available and arranged in geometrical progression. The spindle is of high carbon steel and the bearings of the best anti-friction metal, provided with ring oilers. The carriage is extremely heavy and substantial, provided with T-slots, and is gibbed to the bed for its entire length. The lead screw is located on the inside of the bed, and imparts the motion to the carriage directly under the cutting tool.

The apron is tongued and grooved to the carriage. The reverse of the feeds is not accomplished by means of double bevel gears, as in ordinary lathes, but by means of tumbler gears suitably controlled at front of apron. The screw-cutting feature of this lathe has many special points. All gears are cut from the solid and all shafts are made from high carbon steel. A full description of this lathe can be had by writing to the American Tool Works Company, Sixth street, Cincinnati, Ohio.

A Reed Fog Horn.

The fog horn here illustrated has a large sale in this country and abroad, as it embodies the two requirements of being well designed and well built. It is a reed horn and the operating mechanism is shown in the accompanying cut. There is no inside box to swell and shrink and allow the air to escape, and the valves, which are metal lined with soft leather, hang in an upright position, opening and shutting at the slightest movement of the lever, thus giving a swinging movement with a quick force of air to the horn instead of a rise and fall. No water is required inside the box to swell the wood and limber up the valves before using each time, as is required in other horns.

The horn is blown by moving the crank back and forth, when a large quantity of air is pressed into the chamber and with very little friction. The wear on the bearings and inside working parts is very small. The horn is protected by a galvanized sheet-iron covering

REED FOG HORN.

and placed under the lever. Among the features of construction should be noted the one-piece crank hanger, the turn-down handle having no nuts or pins to break loose, and the leather bellows, which is secured to the solid blocks of wood by being forced into the groove of the wood, held in place by a brass strip. All the bearings and metal parts are of hard brass, made strong enough to withstand many years of service. The manufacturer of this horn is L. D. Lothrop, 66 Duncan street, Gloucester, Mass.

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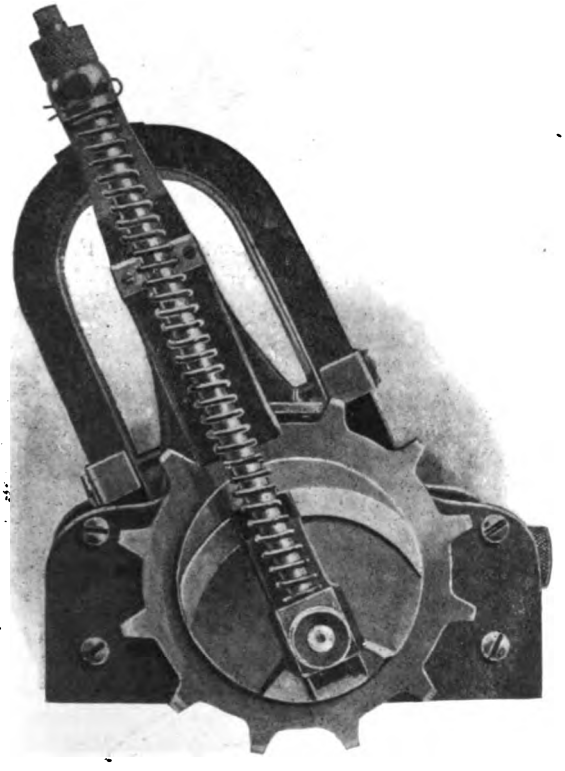
A Novel Magneto.

The advantages and uncertainties in the use of electric batteries for ignition purposes in gas and gasoline engines are well understood by most users. To lessen the wear and tear on the battery the igniter has been applied, but even with this the battery is required for producing the spark upon starting the engine. It is to meet these requirements that the Goodson ignition device, made by the Goodson Electric Ignition Company, Providence, R. I., and which is here illustrated, has been devised and now placed on the market.

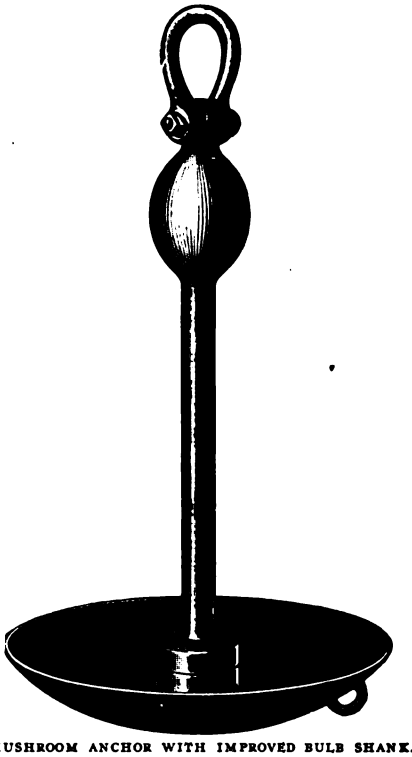
The igniter is an electric generator of the magneto type, provided with a spring-impelling device, connected to a crank on the armature, whereby the armature is made to rotate within the magnetic field for a portion of a revolution at a speed which is entirely independent of the speed of the engine, and which is sufficient to generate the required current to produce a good spark. It is connected directly to the engine shaft, either by sprocket wheels or by gear, and is so arranged that as the shaft turns it puts the spring-impelling device under tension, and is so timed with reference to the position of the piston that the device is tripped into action at the proper time, giving the armature a quick impulse and producing the spark. As the armature revolves only once for every spark made, if the engine be of the four-cycle single-cylinder type the magneto is geared to run only one-half as fast as the engine. If it be of the two-cycle single-cylinder type, then the igniter would be run at the same speed as the engine.



CONSTANT-SPEED MAGNETO.

The igniter is so constructed on a rocking base that the time of the ignition can be varied at will while the engine is in motion.

Briefly speaking, this igniting device is a simple alternating magneto, strongly built, and provided with a little spring attached to a crank on its armature shaft, which is put under tension and tripped into action by the engine, rotating the armature within the magnetic field, producing a single electric impulse and at the proper time to produce the spark. It may be rocked on its base to change the time of ignition at will. The advantages of this machine are, that no batteries or spark coils are required, the mechanism is very simple and armature and brushes are dust- and water-proof, the current is of high tension, the spark produced is of constant strength whatever the speed of the engine.



MUSHROOM ANCHOR WITH IMPROVED BULB SHANK.

Bulb-Shanked Mushroom Anchor.

The mooring anchor, of which the mushroom is the most familiar shape, is a very modern form of shipholder; but in its way this latter type is as perfect an instrument as is its older brother of the stock and flukes. All seamen and yachtsmen know that there is nothing so conducive to peace of mind and quiet sleep when in port as the knowledge that their mooring tackle and ground are of the right kind, and, blow high or blow low, their vessel will remain safely riding in the position in which they placed her. This is peculiarly the case with yachts, as craft of this class spend more days at anchor than they do under sail. But to have this feeling that your ship is safe, she must ride to a mooring, and that mooring must be of such a weight and shape as you are sure will resist all strains of wind and tide. This office the mushroom anchor fills to perfection. It cannot foul the chain, it will not trip, and it seldom drags, and yet when you want it it can be lifted and taken ashore for safe-keeping during the winter months. For mooring purposes it is for this reason the best and cheapest of all mooring devices.

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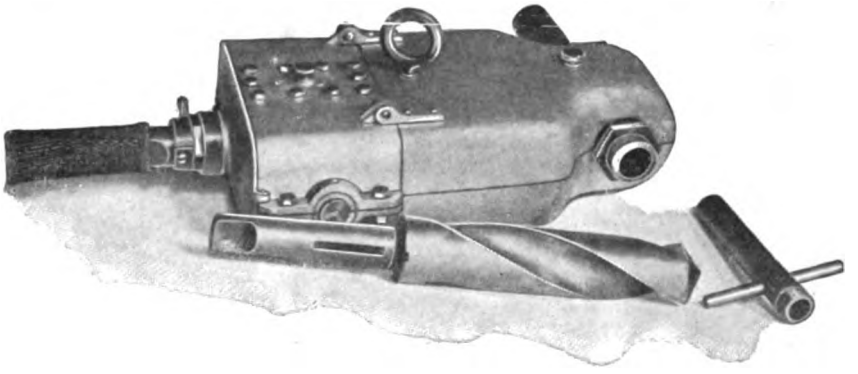
The advantages of this special type are, that the shank is long and heavy to prevent the anchor from taking upright position. The weight of the bulb will throw the anchor on its side and thus remove the danger of having an upright iron rod under the boat. The anchor is made by the Fairhaven Iron Company, Fairhaven, Mass., and in sizes varying from a few pounds in weight and a few inches across the mushroom to 8 feet across the dish and weighing 4 tons.



REVERSIBLE PNEUMATIC MOTOR.

Reversible Pneumatic Motor.

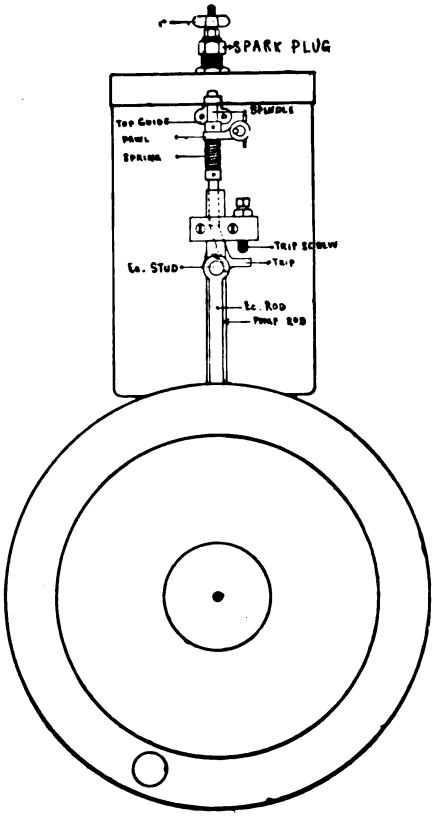
The above cut illustrates a reversible pneumatic motor in connection with means to rotate a spindle in which may be fitted different kinds of tools used in the construction of ships, boilers, bridges, engine and other machinery. It possesses many new features which render it very desirable by manufacturers of this class of work.

As will be seen, the spindle is through the extreme end, so it can be operated in very close quarters. The casing has a hinged lid, by raising which the machinery may be readily inspected, cleaned by air blast, and oiled. The motor has two oscillating cylinders, made of bronze brass, taking air at both ends, the admission and exhaust being controlled by the oscillation. The trunnions have steel ferrules to protect them from wear. In the main frame there are two air chests (one on each side), one for live air, the other for exhaust, and by turning handle half way around the functions of these chests become reversed, thereby reversing the motion and readily controlling the same. By a quarter turn of handle it stops. The air is admitted and exhausted through the handle, which also has an adjustable collar which can be set so that the motor runs but one way only. It has a detachable handle, which is used when the drill is suspended or when used for tapping and reaming.

The largest motor of this type at present built weighs 33 pounds and develops about 2 horse power under 90 pounds pressure, consuming about 17 cubic feet of free air per minute. The maximum speed of the drill spindle is about 200 revolutions per minute under 100 pounds pressure in this size. The speed can be controlled by the handle or throttle to suit requirements. This motor is not in an experimental stage, as it has been in actual service over four years. Among the uses of this end spindle motor may be mentioned drilling door sheets and the holes in flanges of I-beams by setting point of feed sleeve against one flange and the drill in the other, as it is very short from point of feed screw to end of socket. It has very few parts. Other particulars may be obtained by writing the Helwig Manufacturing Company, St. Paul, Minn.

New Igniter.

The cut below represents the new Gray igniter which the Mianus Motor Works, Mianus, Conn., now uses on all its engines. The main feature of this type of igniter is its simplicity. The make-and-break lever is operated by one strong spiral spring. The spring gives the electrodes a positive contact and when released makes a quick break at any speed. Further, all wearing parts are much heavier than usual, which over-



THE GRAY IGNITER.

comes a frequent criticism that all gas-engine igniters are too light and frail. These parts are made of tool steel carefully hardened, insuring longest wear possible, and all parts are interchangeable.

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QUERIES AND ANSWERS.

Q. 122.—Please answer the following questions:

(1).—What are the precautions taken to prevent scale deposits on the interior of boilers using salt water?

(2).—In using lake or river water in boilers what deposits are mostly to be feared, and what precautions are taken to guard against them?

(3).—If you use well water in a boiler that is hard by reason of carbonate of lime or magnesia, how can it be made soft?

A. C. F.

A.—(1) The primary precaution must always be to prevent as far as possible the entrance into the boiler of sea water with its scale-forming constituents. With the suitable provision of modern marine equipment for make-up feed, and, above all, with constant and painstaking care, this can be realized to such an extent as to reduce the inflow of sea water and the scale formed to very small proportions. The chief leakage will be in the condenser, from the salt-water to the fresh-water side, and only the greatest care will serve to keep the condenser tight and prevent such leakage. With such care, however, and other suitable precautions, the amount of scale formed is so small that often little or no additional precaution is taken, and the scale is simply removed from time to time as the periodical examinations of the boilers may indicate necessary.

It is possible, however, to take various steps which will modify to some extent the character of the scale produced by salt water, or reduce its amount. It should be noted that salt-water boiler scale is chiefly sulphate of lime, while fresh-water scale is chiefly carbonate of lime. The former is much the harder of the two, and is more difficult to remove from the heating surface of a boiler. Soda ash or other such alkali has sometimes been employed with a feed water containing sulphate of lime. Such substances act by converting the sulphate into the carbonate, and thus into a somewhat less objectionable form. Barium chloride has also been used, but is relatively expensive. It acts by producing barium sulphate and calcium chloride, neither of which produces a scale. The use of zinc in boilers is also believed to exercise a modifying or preventive influence on the formation of scale by the chemical reaction of the zinc chloride on the scale-forming salts. It must be realized first and last, however, that the great safeguard lies in keeping salt water out of the boiler; in using only fresh water to start with, and only condensed steam for feed, with an auxiliary supply from evaporator to make up for loss; and in a constant watch over the condenser tubes and packing. With these conditions fulfilled it is not too much to say that the old bugbear of scale in boilers is largely a thing of the past, and from one of the most serious has become one of the minor difficulties with which the marine engineer has to contend.

(2) The chief scale-forming constituent of fresh water is calcium carbonate, or carbonate of lime. This is insoluble in water, while the calcium bicarbonate is quite soluble. It is in the latter form that the substance exists in ordinary lake or river water. If now such water is heated to the boiling point the bicarbonate of lime is broken up, carbonic acid is driven off, and the insoluble carbonate is left. This separates out as a more or less powdery deposit, and if alone would not, as a rule, produce a very serious scale. Mixed with a little sulphate of lime, however, or if there should be any sulphuric acid present, or in certain other combinations. a more or less hard and closely-adherent scale is produced. Magnesium bicarbonate, which is also sometimes present in fresh water, is reduced in a similar manner by heat, and may take part in forming a scale.

If the proportion of such substances is small such scale will form very slowly, and often no special precautions are taken to prevent.

Occasional cleaning, as examination may dictate, will thus keep boilers in the desired condition of substantial freedom from any injurious deposit of scale. In some cases, however, the proportion of such substances is larger and active measures are required. Of these the most efficient and satisfactory is the use of some form of feed heater or purifier in which the water is brought to the boiling point and in which the scale is thrown down before it goes on to the boiler proper. The purifier or heater is so arranged as to admit of ready cleaning, and thus the boiler is protected.

A vast variety of substances have been recommended and are in use to prevent the formation of scale in a boiler when fed with fresh water containing the usual impurities of river or lake supply. Some of these substances act chemically, some mechanically, and some perhaps in both ways. From the great variety in the solid matter contained in ordinary fresh water it can hardly be expected that any one mode of treatment will be equally suitable for all cases.

One class of substances includes oak and hemlock bark, which contains tannic acid. This, however, may attack the boiler and cause serious corrosion. Other substances, like vinegar, cane juice, distillery slops, etc., many of which contain some acetic acid, have been used with success where no sulphates are present. The acetic acid is, however, liable to cause corrosion, and such substances can hardly be recommended. Sal-ammoniac may also be used, producing two substances: ammonium carbonate, which is volatile and passes off in the steam; and calcium chloride, which is soluble, but which would gradually accumulate in the boiler unless the contents were occasionally blown out.

Among the substances which act mechanically, crude petroleum or kerosene oils have been much used. It is supposed that they act by preventing close adherence between the particles of scale and the heating surfaces.

Where there is reason to expect in the bottom of the boiler the accumulation of powdery deposits, the bottom blow should be freely used to remove them and to prevent them hardening to scale.

As with salt water, the best safeguard against scale is to keep its constituents out of the boiler. If they enter in only small degree, then watchfulness and suitable cleaning, with perhaps the use of some form of compound found efficient and safe, will satisfactorily insure all interests involved.

(3) The answer to this is suggested by the discussion in (2). Bring it to the boiling point in a preheater and give it time to deposit its solids.

Q. 142 (1).—Will you kindly answer the following through your paper at your earliest opportunity: What are the advantages and disadvantages of the Stephenson link that is used on marine engines?

(2).—Which is the stronger, chain or zigzag riveting, and what is their proportional strength?

F. G. S.

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A.—(1) The Stephenson link valve gear has certain distinguishing features or characteristics, some of which may be viewed as advantages or as disadvantages, according to the special circumstances of the case.

Thus, structurally, the gear involves the use of two eccentrics for each cylinder, and the natural arrangement of the valve chests brings them directly over the eccentrics or in the fore-and-aft line of the cylinders. These arrangements naturally require a certain additional length of engine, due to valve chests and valve gear alone, and independent of other structural considerations. With the various types of radial valve gear the eccentrics are either reduced to one or are dispensed with entirely, and the valve chests, as a rule, are on the sides of the cylinders instead of between them. The Stephenson link gear requires, therefore, as a rule, a longer engine over all than the radial gear, and where the saving of length may be a very important item this feature must be counted as a disadvantage for the Stephenson gear. Actually, however, the difference is not great, as the shortening up of the engine will soon meet a limit in the necessary dimensions of the shaft, in order to provide the necessary lengths of crank pin, lengths of pillow-block bearing, thickness of crank web, etc., to say nothing of the diameters of the cylinders themselves.

On the other hand, compared with the radial gears in general, the Stephenson link consists of fewer parts, and is, on the whole, simpler mechanically. It is also usually considered to be, on the whole, rather less liable to break down than the radial gears, though with either this is merely a matter of good design. In particular the Stephenson link has fewer pin joints than most of the radial gears, and wear at the joints and moving parts does not produce so great a disturbance in the valve events and steam distribution as with the radial type of gear.

As regards the valve events and steam distribution, there is comparatively little difference between the two types of gear, in spite of the various claims made for the radial gears. With either the cut-off may be readily varied by linking up, and the engine may be reversed by an extension of the same operation. With the usual open-rod form of Stephenson link the lead increases as the gear is linked up and the cut-off made earlier. With the radial type of gear the lead under like conditions remains the same. This is a characteristic of the radial gear and under some circumstances may be considered an advantage, while the corresponding change of lead with the Stephenson link would be a disadvantage. Most engineers are agreed, however, that there is no marked advantage in the mere fact of constant lead as the gear is linked up, and are quite ready to accept the slight increase which is given by the Stephenson link. On the other hand, the decrease of valve travel and of port opening is less rapid, as the gear is linked up, with the Stephenson link than with the radial gears. In all such gears the port opening is cut down with earlier cut-off, but in the Stephenson link with open rods it is less pronounced than with the radial gears.

Considered either structurally or as a mechanism for operating the valves of a marine engine, the Stephenson link has more than held its own in competition with the various other types of gear, and to-day may be fairly considered as the typical or standard type of marine valve gear the world over.

(2) With riveted joints properly proportioned, there is little or no difference in the strengths or efficiencies of the two styles of riveting. Certain experiments have, however, indicated a slight margin in favor of chain riveting. The difference, however, is small at most, and in many experiments is more than masked by differences between individual joints of the same type. So far, however, as there seems to be a difference it is rather in favor of the chain-riveted joint. It is not possible, however, to state any relative strength; the difference is too uncertain and too slight. It should be understood that, quite independent of this question of relative strength, zigzag riveting is usually employed in all multiple-riveted joints which are required to be water- or steam-tight. The reason for this is readily seen to be in the fact that the zigzag distribution of rivets naturally gives a tighter joint than the chain distribution. On the other hand, where water- or steam-tightness is of no consequence, as in bridge or other structural work, chain riveting is often, or perhaps even commonly, employed.

Q. 144.—Will you please give me the rule to find the efficiency of coal; that is, if one kind is 1.1 per cent. and another is 1.2 per cent. Also the rule for displacement of ships.

A. J. S.

A.—There is no such thing as efficiency of coal, and we are at a loss to understand the first part of your question. Coal is composed of carbon and volatile matter, which in hard coal ranges about 84 per cent. of carbon and 3 or 4 per cent. of volatile matter, and in soft coal about 60 per cent. of carbon and 30 per cent. of volatile matter; the remaining percentage is made up of moisture, ash, etc. It is the burning of this carbon and volatile matter which produces heat. One pound of pure carbon burned to carbonic acid gives 14,600 British thermal units. This unit is used for measuring heat, and one unit being equivalent to the heat required to raise the temperature of one pound of water from 60 degrees temperature F. to 61 degrees. Good anthracite coal has a heating value of about 13,500 B. T. U., and the best qualities of bituminous coal range from 14,000 up.

There is always a certain amount of moisture in coal, which ranges from 1 to 6 or 7 per cent., and it may be that you have gotten this figure confused with the efficiency.

The rule for finding the displacement of a vessel is: First, to find the cubical contents in cubic feet and divide this by 35, which is the number of cubic feet in a ton. This is for salt water; if the vessel floats in fresh water divide by 36. The cubical capacity of the ship is found by multiplying the length between perpendiculars × the mean draft × a coefficient. This coefficient is known as the block coefficient, and varies from .45 or less for yachts to .86 for big freight steamers. This figure can only be obtained from the displacement calculations.

Q. 145.—As a constant reader of your paper I take the liberty to ask these questions regarding an experiment of mine:

I have an iron lifeboat 22 feet 6 inches over all, 6 feet beam, and 32 inches deep amidships. I have tunneled the after air tank for shaft and contemplate trying to put power in the boat as follows: One boiler, built on the Salamandrine type, but with what I think an improvement of 65 square feet of heating surface with 3-4 inch steam outlet, burning kerosene oil as fuel, carrying 200 pounds pressure per square inch. One vertical com-

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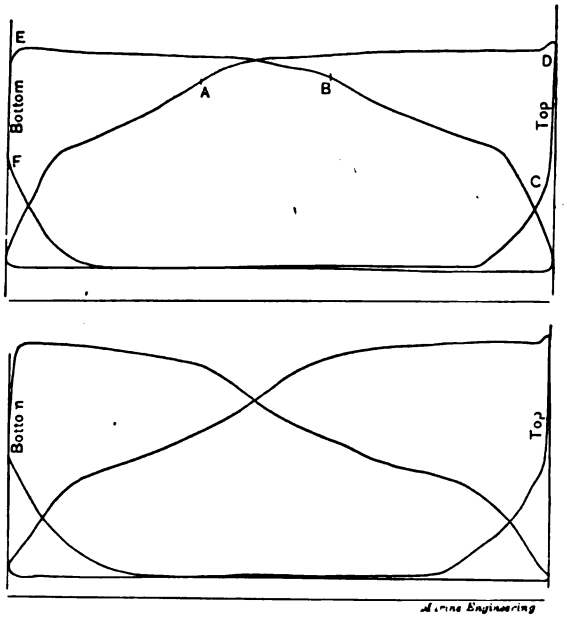
pound engine with slide valves, 3 1-2 by 6 by 4 inches stroke, with 14 square feet cooling surface in keel condenser. I anticipate using a 20-inch diameter propeller. What would be most efficient, a three- or four-bladed propeller? What is the best pitch and blade area? And what speed could I expect to get out of a boat weighing about 2,000 pounds? W. M. M.

A.—Your question leaves a good deal to the imagination; that is, to be assumed before any results can be stated. Probably your mean draft with machinery installed will not be less than about 18 inches, which would correspond to a displacement of about 3.4 tons. Then if you are able to maintain 200 pounds of steam on your boiler and turn your engine up to about 400 revolutions per minute, you should realize a reduced mean effective pressure of perhaps 80 pounds and develop about 20 I. H. P. If such conditions could be maintained, then you might look for a speed of 9 or 10 miles per hour, provided your boat were not so bluff as to make such a speed entirely out of the question. To absorb this power and to develop any such speed, however, you need a propeller larger than 20 inches diameter. Computation shows that for 400 revolutions per minute the propeller under such circumstances should be about 26 inches diameter and 34 inches pitch. If you use a 20-inch propeller your engine, under the conditions assumed, would simply run away with it; you will get high revolutions and large slip, but will not realize the corresponding speed. If you must use a diameter of 20 inches, however, then use four blades with plenty of area, say 140 square inches, with a pitch of about 30 inches, and experiment with the engine till you get the best results practicable from the combination.

Q. 146.—Will you please give your opinion regarding these two sets of cards from the high-pressure cylinder of a compound engine? The stroke is 32 inches; steam pressure at engine 145 gage. The revolutions for set number 1 were 82, with cut-off at 20 inches; and for set number 2, 76 revolutions and cut-off at 16 inches. The clearance at top is 1-2 inch and at the bottom 5-8 inch. In particular I should like to know whether there is anything to show if the piston valve leaks. P. F. V.

A.—Taking card number 1 first, we can easily pick out the point of actual steam closure at about A for the downstroke and B for the upstroke. These figure out 66 per cent. for the downstroke and 59 per cent. for the upstroke, giving a mean of 62.5 per cent., which corresponds to the 20-inch cut-off. The initial pressure scaled from the cards is 134, which shows some considerable wire-drawing through the ports, and suggests that the ports are perhaps a trifle small. Again, looking carefully at the lead line on the two ends, the slant of the line *CD* is plainly seen, indicating a suitable lead on top. There is no such line at the other end, and the rounded corner at *E* indicates, with the shape of the line *FE*, that probably the lead at the bottom is very small, or, perhaps, nothing at all. It might help matters to lengthen the valve stem slightly, thereby increasing the lead on the bottom and decreasing it on top, though the card does not show any evidence that the lead on the top is too large. Any other adjustment, however, would involve changing the lap on the valve, and that would be hardly practicable, except with a general overhaul. So far as the other events on the card are concerned, release seems to occur at about 9 per cent. on top and 10 on the bottom, while compression begins at about 13.5 per cent. on top and 15.5 on the bottom. These are fair values and suggest nothing wrong with the exhaust side of the valve. So far as the card can be measured up and estimates made, there does not seem to be evidence of leakage past the valve, or, at least, if there is such leakage it is quite small.



Referring to set number 2, the cut-off is at about 55 per cent. on top and 45 on the bottom, a mean of 50 per cent., agreeing with the 16-inch cut-off. The release is at about 13 per cent. on top and 14.5 on the bottom, while the compression is at about 17.5 per cent. on top and 20.7 on the bottom. These various differences are all consistent and correspond to the gear in the linked-up position. The initial pressure scales a little higher, about 136 pounds, which may be due to the lower revolutions and decreased wire-drawing. The difference in the lead at top and bottom is still seen, and is the chief point which seems to call for adjustment.

On the whole, the cards are well formed and indicate quite as satisfactory a balancing of the various events, etc., as is commonly found.

Q. 147.—I am a constant reader of your magazine and hope to be a marine engineer myself some day, and so would beg leave to ask if you would publish in the next number of Marine Engineering some of the most difficult and important questions regarding marine boilers and engines that a person should be able to answer to obtain a first-assistant engineer's license of a vessel of about 1,500 tons. Also, are there any special questions asked by the examiners regarding electricity? C. H.

A.—Space does not permit us to give all the important points about which an applicant should be conversant in order to pass the examination for assistant engineer. We presume that you are at present working in the engine room of a ship, as this is a necessary qualification for taking examination, and suggest that you first get a copy of the rules issued by the United States Steamboat Inspection Service, Department of Commerce, Washington, D. C., and also that you purchase some of the books on marine engineering. *Practical Marine Engineering*, by Professor W. F. Durand, is most eminently suited for your purpose; also might be mentioned Lucas' *Questions and Answers*.

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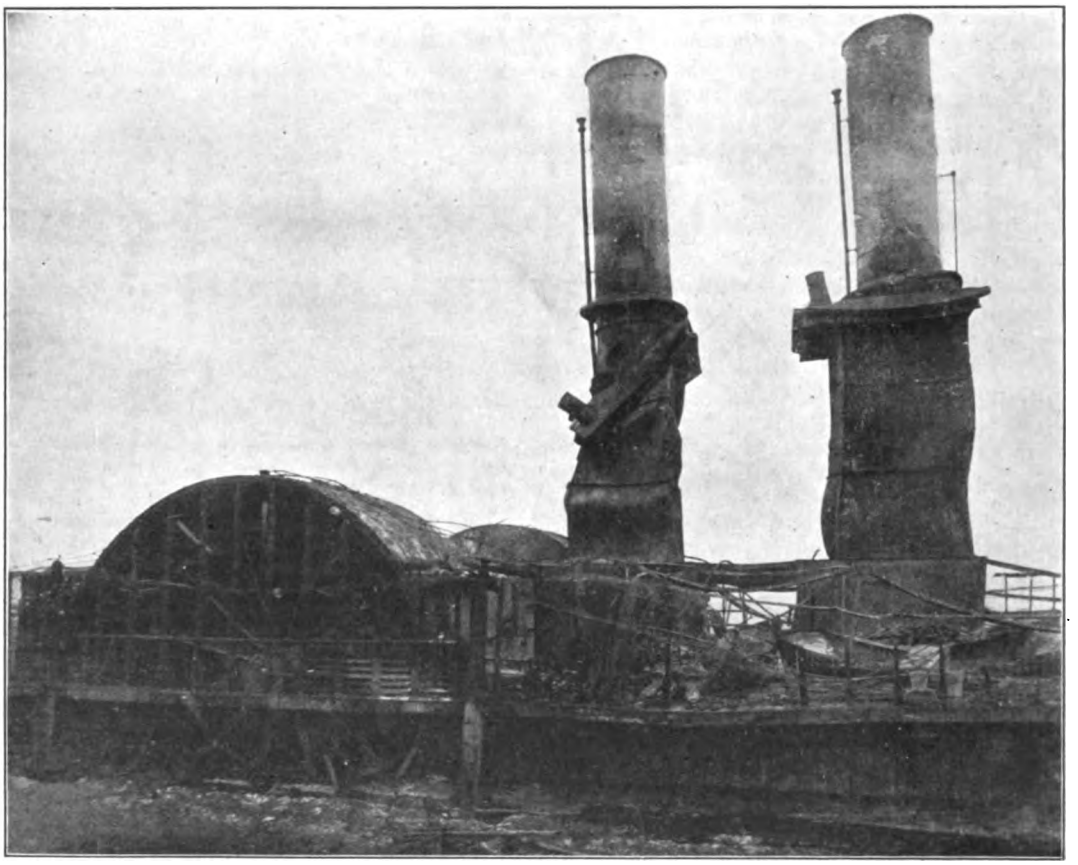
Burning of the New Steamer Montreal.

A most spectacular fire took place in the St. Lawrence river off Montreal on Saturday night, March 7. In the early evening the new steamboat *Montreal*, of the Richelieu and Ontario Navigation Company, caught fire and the upper works were entirely destroyed. The vessel was nearing completion and was about to be delivered to the owners. She was moored in the river near the Allan line pier, but the fire department of the city was entirely unable to check the flames, and only with difficulty prevented the spreading of the fire to the adjoining property. The *Montreal* was launched from Bertram's shipyard, Toronto, in 1900, and brought down through the rapids to Montreal, where the joiner work was completed and the vessel equipped. The hull was of steel, but above the main deck all was of wood. The painters had been at work on the vessel, and it is presumed that the fire broke out among the cans of paint stored on board; at any rate, within a short time from the sounding of the alarm the entire ship was a sheet of flame.

Thousands of people came down to the river front to witness the fire, and many climbed on the rafters and beams of a new freight shed being erected on the wharf. Suddenly this framing gave way and the roof fell down, injuring scores of people. The *Montreal* was to be used in the summer night service between Montreal and Quebec and to replace the steamer of a similar name running on this line. She was 340 feet length over all and was propelled by a compound inclined engine with feathering paddle wheels. At the time of going to press, it is not known how much of the hull and machinery may be saved. Three hundred and fifty thousand dollars had been paid by the Richelieu and Ontario Company to the builders on the contract price of $500,000 The loss is covered by insurance.



NEW STEAMER MONTREAL, BURNED TO THE WATER'S EDGE AT MONTREAL, MARCH 7, 1903.

PERSONALS.

N. W. Akimoff has left the hull department, drafting room, of the New York Shipbuilding Company to take a position in the engineering department of the Marine Engine and Machine Company, of Harrison, N. J.

William N. Finkenaur is now employed as a fitter at Townsend-Downey Shipbuilding Company, Mariner Harbor, New York. He was formerly a draftsman in the electrical department at the Cramp yard.

Edson F. Gallaudett, formerly of the Cramp company, has accepted a position with the New York Cash Register Company, Dayton, Ohio.

William F. Norton has gone with the Manitowoc Dry-Dock Company, Manitowoc, Wis., as general draftsman. His former position was as steamfitter of the Chicago Shipbuilding Company.

George C. Cook has removed to 130 Water street, New York, and besides his former business as naval architect. he is now conducting a brokerage business.

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F. H. Hibbs, formerly naval constructor, for three years stationed at the Puget Sound Navy Yard, has resigned from the service and will enter the employ of Moran Bros. Company, Seattle, Wash.

Clifford Lee, Jr., who was formerly draftsman of the Crescent shipyard, Elizabeth, N. J., has taken a position as draftsman with the American Locomotive Company, Richmond Works, Richmond, Va.

Jargen Rasch has gone with the Westinghouse Machine Company, East Pittsburg, to work in the designing department.

Perry K. Thurston has left the drafting room of the Neafie and Levy Ship and Engine Building Company to accept a position as draftsman with the Bureau of Steam Engineering at Washington, D. C.

Arent Arneson, who formerly had a position in the drafting room of William R. Trigg Company, has accepted a position with the American Locomotive Works at Schenectady, N. Y.

H. S. Webster, formerly of the hull department of the Bath Iron Works, has accepted a position with the New York Shipbuilding Company in the hull drafting room.

Chas. C. Turner, formerly of the Bath Iron Works and Thomas Lawley and Son, has accepted a position with the Fore River Ship and Engine Company.

John L. Denny, formerly connected with Denny Bros., Scotland, and with the Bath Iron Works, Bath, Me., has accepted a position with the Fore River Ship and Engine Company in the hull drawing office.

John A. Price, who held a position as draftsman with the Bath Iron Works, has taken a position in the drafting rooms of the New York Shipbuilding Company.

Chas. Brown has severed his connection with the Hyde Windlass Company, Bath, Me., where he has been employed for a number of years in the counting rooms.

E. S. Farwell, formerly connected with the International Power Company as expert steam engineer, has opened offices as consulting engineer at 309 Broadway, New York, N. Y.

C. M. Andrews, who was formerly in the drafting room of the Wm. R. Trigg Company, has gone to the New York Shipbuilding Company, where he has taken a position as draftsman.

At the meeting of the stockholders of the Newport News Shipbuilding and Dry-Dock Company, held at Newport News, Va., on March 13, the old directors were re-elected, and Calvin B. Orcott, of New York, was re-elected president of the company. Mr. Orcott has been president since the establishment of the yards.

A New Submarine Boat.—The submarine torpedo boat *Protector*, built by Simon Lake, Bridgeport, Conn., is being prepared at City Island, N. Y., for a series of trials that are soon to be held to test her capabilities. The *Protector* is 60 feet in length, 11 feet wide, and 12 feet deep.

Steamer City of Macon.—The Savannah Line steamer *City of Macon*, for the New York and Savannah passenger and freight service, was launched from the Delaware Shipbuilding and Engine Works, Chester, Pa., March 14. The vessel is 400 feet long, 50 feet beam, and will carry 14,000 bales of cotton besides perishable fruits.

TECHNICAL PUBLICATIONS.

Elements of Steam Engineering. By H. W. Spangler, Arthur M. Greene, Jr., and S. M. Marshall. Size 6 by 9 inches. Pp. 275. Price $3.00. John Wiley and Sons, New York, N. Y.

The purpose of this book is to instruct beginners in the different forms of steam apparatus and power plants and to explain briefly the construction and reasons for using the various parts. It is divided into nine chapters, dealing with boilers and auxiliaries, the steam engine, valve gears and diagrams, the uses of governors and valves, and the principles of condensers and multiple expansion. As the word implies, the book is most elementary and begins with describing the methods of generating heat and different types of boilers. Necessarily such a volume will be a description of specialties made by different manufacturers. The subject of boiler details is touched upon, such items as grates, stokers, furnace doors, dampers, pipe fittings, valves, riveting and staying, being treated in a general way and well illustrated. Under the head of Boiler Room Auxiliaries are described steam pumps, feed heaters, stacks, and forced and induced draft, also methods of conveying coal and ashes about a steam plant. The different parts of an engine are then taken up and their functions stated in simple language. Excellent detail drawings are given of the different types of connecting rods, crossheads, pistons, etc., for stationary, locomotive, and marine practice. The attempt has been made to cover the entire field in a cursory manner by the use of many illustrations. The province of the steam valve is then taken up, and the method of drawing a valve diagram is given. The different forms of valve gears are illustrated, and then follows the chapter on Indicating and Governing, containing the usual information on the methods of applying the indicator and reading and calculating the cards. In the last chapter the vacuum produced by condensed steam is explained, and then follow a few pages and illustrations of the different types of multiple-expansion engines.

Throughout the book the purpose of the authors has been to give to the student a working vocabulary, as well as an understanding of the steam engine, and the name of each part of any design is set in heavy type. As an elementary book it will doubtless take its place in the library of the steam engine.

Supplement United States Standard Registry of Shipping, 1903. Size 10 1-2 by 9 inches. Pp. 20. United States Standard Registry of Shipping, 18 Exchange Place, New York, N. Y.

This supplement is written especially to meet the demand for rules covering the construction of vessels carrying oil in cargo. Until recently shipbuilders have had to carry on the oil-tank work without the guidance of special rules, as this form of construction is comparatively novel, and not sufficient information was at hand from which to draw up rules. The rules in the new supplement are to be used in addition to those of the main volume published a few months ago. The general requirements for the form of construction are briefly stated, among which might be mentioned that the cargo shall be carried to the shell plating and that a continuous oil-tight longitudinal bulkhead be fitted; that the thwartship bulkheads shall not be over 30 feet apart and

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no oil shall be carried at the bow and stern of the vessel; that each compartment must have its own extension trunkway; that a cofferdam shall be fitted at each end of cargo spaces and no oil shall be carried in cofferdam. Rules for the structure of the ship are mostly similar to those for ordinary service, but special attention is paid to bulkheads, cofferdams, extension trunks, tunnels, and riveting. As the ventilation of oil-carrying spaces is absolutely essential to prevent explosion, this subject is well covered by the rules.

It is recommended that machinery and boilers be placed aft the cargo space and that no oil pipes, other tnan those used for bunker oil, are to pass through the boiler or engine spaces. The question of pumping cargo oil is taken up and pumps of ample capacity prescribed. Where oil is used under the boilers it must not have a flash point less than 150 degrees Fahrenheit. All lighting, except the running lights, must be by electricity on oil carriers. Taken as a whole the supplement will cover the construction of oil-tank vessels, and, while laying down few definite rules, the recommendations will be found most useful.

Turning and Boring Tapers, 1902. By Fred. H. Colvin. Size 5 1-2 by 8 1-4 inches. Pp. 24, with 21 illustrations and tables. Price 25 cents. The Derby-Collard Company, 256 Broadway, New York, N. Y.

This is the first of a series of practical papers to be devoted to the methods of turning and boring the usual form of tapers. The subject is treated in an eminently practical style, such that the little book will be of value to all machinists who wish to post themselves on ordinary forms of turning and boring tapers. The proper way of setting the lathe and the method of calculating the angle are clearly given, and then are described the method of cutting tapers with a combined rest and boring tapers and cutting tapered threads. The pamphlet is written in a direct and clear manner and well illustrated.

Injectors, Their Construction, Care, and Management. By Frederic Keppy, M.E. Size 6 by 9 inches. Pp. 70, with 45 figures. Price 25 cents. The Marine Industrial Publishing Company, Bridgeport, Conn.

It is safe to say that but comparatively few engineers understand the theory of the injector, which has now been in use in this country over forty years. The author in this little treatise gives an interesting historical sketch of the first injector, which, by the way, is practically identical to the modern types, and then states the conditions on which the operation of the injector depends. There are very many kinds of injectors, single tubes, double tubes, adjustable tubes, each of which has its special service. The different kinds on the market are described in a well-illustrated chapter. The use of a siphon or ejector is briefly considered, and the closing chapters are devoted to the care and use of injectors and the causes of their failure to act. This is a handy little book for any engineer's desk or engine room.

Technolexicon.—It is a well-known fact that a technical dictionary, comprising a complete vocabulary of terms of all the industries and their many branches, has been missing heretofore. Being aware of this fact, and of the great difficulty of such a task, the Society of German Engineers, in co-operation with other technical and industrial societies, domestic and abroad, are to publish a dictionary, called the *Technolexicon*, in the three mostly-used languages, English, French, and German.

This comprehensive work was inaugurated in March, 1901, by a publication which appeared in the paper of the Society of German Engineers, and, shortly after that, notices were sent to technical societies and individuals in Germany and abroad, stating the manner and ways in which contributions to the *Technolexicon* could be furnished. An idea of the comprehensiveness of the work can be obtained from the statement of Dr. Hubert Jansen, the editor in charge of the undertaking, whose name has already become connected with other encyclopædic works, in which he states that though words have already been gathered for one and a half years by societies and individuals in Germany, Belgium, France, England, and the United States, the collection will probably not be completed before the end of the year 1904 and the manuscript will be ready about the end of the year 1906.

Not only contributions of technical terms with the translations are valued, but also such contributions which, in giving merely the technical term, give, at the same time, an explanation thereof; also contributions regarding the customary phrases of the country in which they are used are highly appreciated. If terms are given which are very uncommon, it is desired that the source be given where the term may be found.

Besides this principal source of contribution it is found that catalogues, price lists, etc., of industrial firms, from which technical terms can be gathered, are of value, and it is desired, therefore, that all the manufacturing firms publishing printed catalogues, price lists, etc., send a copy of same to the Editor of *Technolexicon*, Dr. Hubert Jansen, Berlin, N. W. (7), Dorotheenstrasse 49. This is thought to be of interest to such firms, as the book will undoubtedly prove of valuable assistance in the work of translating catalogues from one language into another. All those who may desire to contribute through collecting terms and phrases, may apply for note books, especially arranged for that purpose, and for letters of information, directly to the editor, or to Dr. Alfred Mueller, 150 Nassau street, New York, N. Y.

New Trial Trip of H. M. S. Good Hope.

An interesting detailed description of the recent voyage of H. M. S. *Good Hope*, from England to Cape Colony, has been given in *London Engineering*. The voyage was of general interest, due to the fact that the ship carried Mr. Chamberlain to South Africa, but the voyage was of special engineering interest in that the *Good Hope* had but recently completed her contractor's trials and had not been tested for a long run.

The *Good Hope* is an armored cruiser of the following dimensions: Length over all, 500 feet; beam, 71 feet: draft, 26 feet; displacement, 14,100 tons. The machinery consists of two sets of 4-cylinder triple-expansion engines balanced on the Yarrow-Schlick-Tweedy system, the low-pressure cylinders being at either end. The cylinder diameters are 43 1-2, 71, 81 1-2, 81 1-2 inches, and the stroke is 48 inches; total cooling surface in both condensers, 32,000 square feet. The boiler equipment comprises 43 Belleville boilers with 382 elements in all, the total heating surface being 71,964 square feet, and the grate surface 2,314 square feet. The total weight of

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machinery complete, including water in the boilers, is 2,540 tons. On the official trials a speed of 23.05 knots was maintained, with the engines indicating 31,088 horse power on a consumption of 1.92 pounds of coal per I. H. P.

Her engine-room complement during the official trials was 438, while on this trip there were but 292 men in the engineer's department. The ship was ordered to speed at 17 knots. From Portsmouth to Durban, besides the 150 tons of fresh water normally carried, a further supply of 279 tons was taken in the double bottoms, to be used if the evaporators were not sufficient to make up the lost steam. The start was made on the afternoon of November 25, with 27 of the 43 Belleville boilers under steam, the engines running at 85 revolutions, corresponding to a speed slightly over 17 knots. Much rough weather was experienced. The starboard intermediate crank pin became so heated on the 30th that the starboard engine was shut down, the brasses replaced, and the crank pin smoothed, filed, and rubbed over. On December 3 the ship entered the Suez Canal, having completed the run of 3,100 miles in 189 hours. December 5 and 8 were spent in overhauling machinery and taking on board 2,000 tons of coal.

The *Good Hope* sailed on the morning of the 8th for Zanzibar, a distance of 2,850 miles, completing the run in 170 1-2 hours at a speed of 16.7 knots. The heat of the Red Sea was greatly felt in the boiler rooms. On the 13th the bilge suction in the starboard engine room became choked, which caused the crank pits to fill with water. This washed out the oil from the starboard intermediate-pressure crank-head brasses, causing them to heat up, and the engine had to be eased off for cooling down. On the 15th Mr. and Mrs. Chamberlain were landed at Mombasa, near Zanzibar, and did not re-embark for Durban until December 21, during which period the ship was again coaled and opportunity given the engine-room force to re-examine and overhaul the starboard intermediate bearing and to adjust other bearings where necessary. Small defects in auxiliary and other engines were also rectified. As Mr. Chamberlain was not expected to arrive at Durban until the morning of the 26th, this last run of 1,600 miles was made in 15 knots.

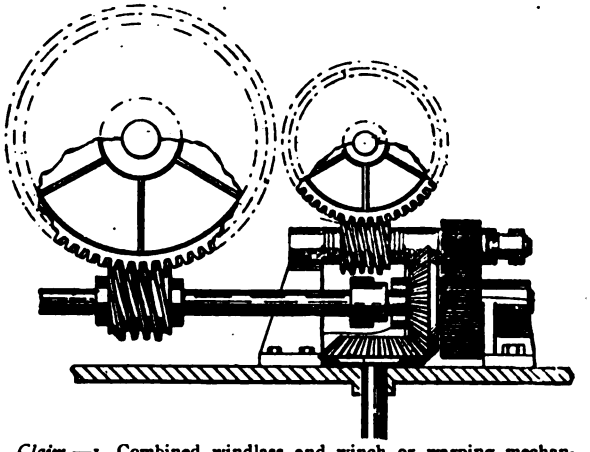
The boilers throughout the trip worked excellently. The plan for running them was to keep 27 of the 43 boilers under steam, cutting out 16 of those which had been running each morning and lighting the fires under 16 fresh boilers. A staff of men in the daytime made any necessary repairs of the boilers out of commission, cleaning and swabbing them, etc. Taking into account the fact that during the greater part of the voyage 45 auxiliary engines were almost continuously in use in addition to the main engines, the coal consumption of 2.66 pounds per indicated horse power for all purposes is fair. The indicated horse power for the run from Portsmouth to Port Said averaged about 10,300; from Suez to Zanzibar about 8,500; from Zanzibar to Durban 6,300. No measurement of the water evaporated was kept, but the ship's evaporators, working on the "closed exhaust," supplied sufficient water for drinking purposes and to make up the boiler loss; the extra 279 tons of fresh water taken in double bottoms at Portsmouth were not used.

On the first and second runs about 65 deckhands were used in trimming and stoking, and on the last run about 19 deckhands were used as stokers.

SELECTED MARINE PATENTS.

720,137. MEANS FOR RAISING SUNKEN LOGS. BERT H. HARRIS, REED CITY, MICH. Eight claims.

720,197. COMBINED WINDLASS AND WINCH. HENRY D. VAN DOORN, PROVIDENCE, R. I., ASSIGNOR TO AMERICAN SHIP WINDLASS COMPANY, PROVIDENCE, R. I., A CORPORATION OF RHODE ISLAND.



Claim.—1. Combined windlass and winch or warping mechanism whose respective shafts are geared up to separate shafts, adapted to be differentially geared together, and to the driving shaft, substantially as set forth. Ten claims.

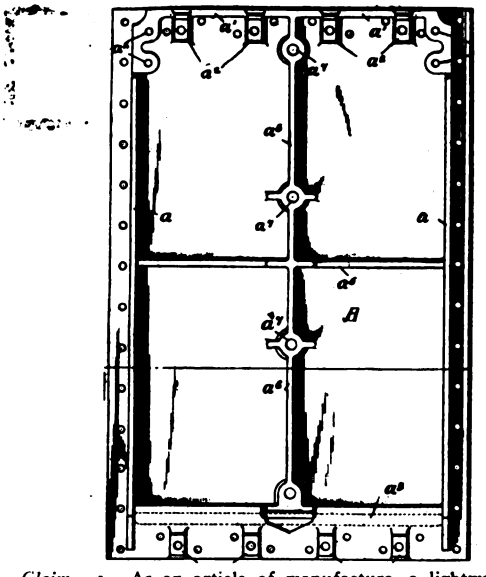
720,216. HATCHWAY GATE. JOHN BAYER AND HERBERT W. WIGAN, NEW YORK, N. Y. Nine claims.

720,557. MECHANISM FOR UNLOADING VEHICLES, ETC. VICTOR R. BROWNING, CLEVELAND, OHIO.

Claim.—1. In an unloading mechanism for vehicles, a cradle having buffers and a tilting platform for the vehicle mounted in said cradle in such a manner that when the cradle is moved toward the unloading position, the platform will be automatically tilted with reference to the cradle toward the said buffers. Eight claims.

720,897. MOTOR POWER FOR BOATS. FRED. A. CREED, WHATCOM, WASH. Two claims.

721,024. BULKHEAD DOOR. WILLIAM B. COWLES, CLEVELAND, OHIO, ASSIGNOR TO "LONG ARM" SYSTEM COMPANY, CLEVELAND, OHIO, A CORPORATION OF WEST VIRGINIA.



Claim.—1. As an article of manufacture, a lightweight bulkhead door, consisting of a single piece of cast metal having one of its faces plane and the other face provided with strengthening and retaining ribs, said door being made by casting a blank of about twice the required thickness and planing off one face thereof until the door is reduced to the required thickness.

721,012. MARINE-ENGINE GOVERNOR. EDWARD C. BUCK, PRETORIA, TRANSVAAL, SOUTH AFRICA.

Claim.—1. In apparatus for controlling the supply of steam to marine engines, the combination with a pendulum of a toothed quadrant fixed to a frame integral or fixed to said pendulum and situated above the point of suspension of the pendulum, a valve chest in the main steam pipe near to the steam generator, a pair of steam ports in said valve chest, a pair of slide valves adapted to cover or close said ports, a spindle formed with right- and left-hand threads engaging nuts upon the back of said slide valves, and a pinion upon said spindle engaging said toothed quadrant and adapted to be rotated thereby. Two claims.

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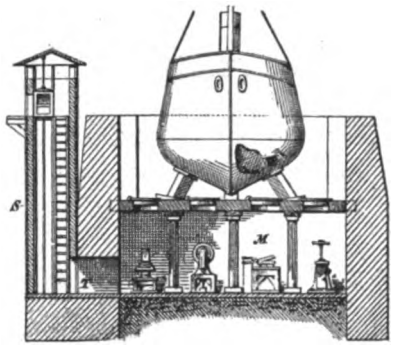
721,222. DRY-DOCK. JOHN F. O'ROURKE, NEW YORK, N. Y.

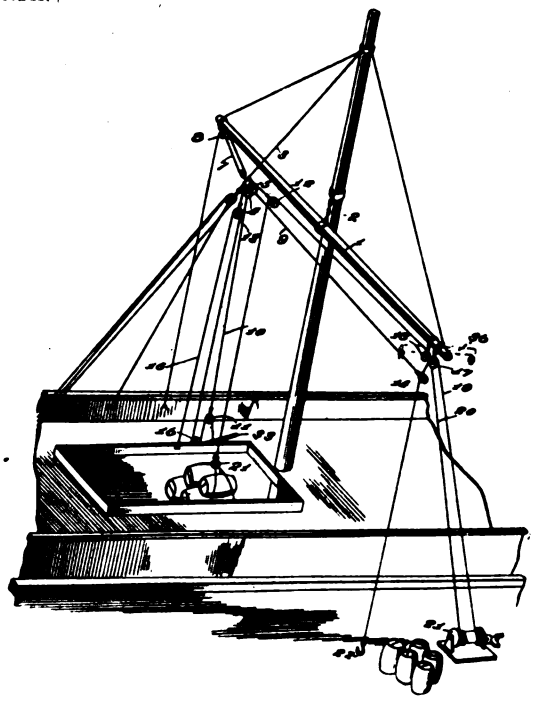


Claim.—3. The combination in a dry-dock of a chamber or room below the resting place provided for the vessel, communicating doors connecting the chamber with the dry-dock, and an entrance to the chamber from the outside. Three claims.

721,223. DRY-DOCK. JOHN F. O'ROURKE, NEW YORK, N. Y.

Claim.—2. The combination in a dry-dock of one or more chambers connected therewith by a door or opening in the wall thereof, closed by water-tight gates and having communication with the surface of the ground in which the dock is situated. Two claims.

721,067. HOIST. WILLIAM L. McCABE, SEATTLE, WASH.

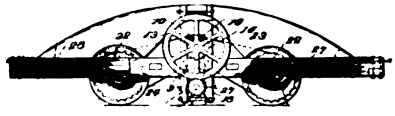


Claim.—1. In a hoist, the combination with a suitable yard and a suitable stay, of a block carried by said yard, a block carried by said stay, a cable passed through the block of said stay and carrying a block at each end, a cable passed through the block of said yard and one of the blocks of said cable, means for moving said last-mentioned cable longitudinally, a cable passed through the other block of the first-mentioned cable, and means for locking the same against movement. Eight claims.

721,286. SAIL. JOEL COUCH, CLAYTON, N. Y.

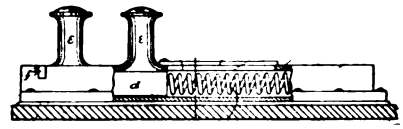
Claim.—1. A sail made of a series of sections, each of which has a free baggy edge intersecting pockets to which the fixed edges of the sections are connected, a rotatable mast, a boom to which said sail sections are connected, and which boom is mounted to move with the mast. One claim.

721,347. DEVICE FOR CLEANING THE BOTTOMS OF VESSELS. EDWARD S. WILLEY, ELIZABETH CITY, N. C., ASSIGNOR OF ONE-FOURTH TO RICHARD O. CRISP, ELIZABETH CITY, N. C.



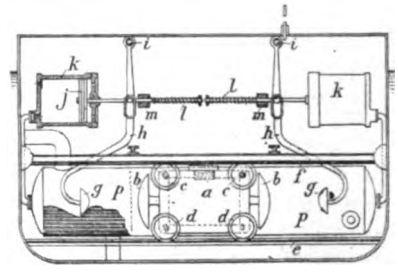
Claim.—1. In a device for cleaning the hull of a vessel, the combination with a suitable frame carrying gripping rollers, of vertical journal-box frames provided with spring-pressed slidable journal boxes, a cutter mounted in the lower journal boxes, provided with a gear wheel, a main shaft mounted in the upper journal boxes, provided with a gear wheel meshing with the cutter gear wheel, and means connecting the gripping rollers with the main shaft, whereby when said device is moved back and forth rotary motion is imparted to said main shaft and thereby to the cutter. Four claims.

721,465. HAWSER ATTACHMENT FOR VESSELS. RICHARD C. REAVLEY, PENARTH, ENGLAND.



Claim.—1. A cable or hawser attachment for vessels, comprising an elongated keeper adapted to be secured to the deck of a vessel or other support and having a longitudinal opening in the top thereof, a slide mounted in said keeper and provided with bitts which pass upwardly through said opening, a spring placed in said keeper and between one end thereof and the slide, and a cover plate secured to the slide and adapted to partially close the opening in the top of the keeper and protect said spring, said keeper being also provided at one side of the slot or opening in the top thereof with a scale, and said slide being provided with a pointer which operates in connection with said scale. Two claims.

721,501. WAVE OR TIDE MOTOR. CHARLES CAILLE, LE PERREUX, FRANCE.



Claim.—1 In an apparatus of the class described, the combination with the boat, of a weight adapted to be moved by gravity from one side of the boat to the other, an air compressor, and a lever adapted to receive the impact of said weight and impart the force thereof to the piston of said air compressor, substantially as described. Four claims.

721,663. SHIP'S ANCHOR. HENRY J. BROOKE, SVENDBORG, DENMARK.

Claim.—1. In an anchor, a shank having a spirally-disposed guideway upon its lower end and a pair of arms rigidly secured to the end of the shank in combination with a pair of movable arms having an aperture adapted to loosely receive said shank and move upon said guideway, whereby when both pairs of arms are in contact with each other they will be disposed at right angles, and when said movable arms are moved up the shank in said guideway they will be turned by said guideway and disposed substantially parallel with the fixed arms. Two claims.

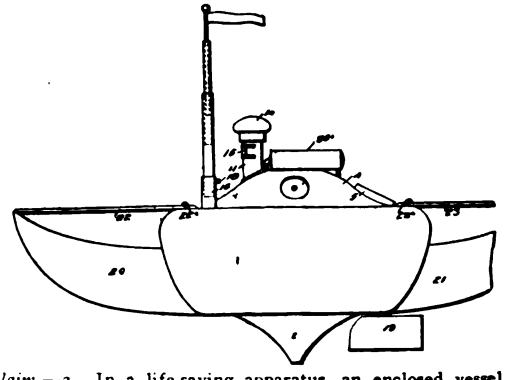
721,677. GROUNDING PREVENTER FOR MARINE VESSELS. CHARLES DORNFELD, NEW YORK, N. Y. Two claims.

721,868. BOAT. CLEMENS DROHOVITH, WEST SUPERIOR, WIS. Two claims.

721,851. APPARATUS FOR EXTRICATING STRANDED VESSELS. JOHN ARBUCKLE, BROOKLYN, N. Y.

Claim.—2. An apparatus for extricating a stranded vessel, comprising in combination a device for loosening the mud, means for guiding said device alongside the hull of the vessel, and means for removing the loosened mud from the hull of the vessel. Seventeen claims.

721,690. LIFEBOAT. ROLLAND FORREST, PHILADELPHIA, PA.



Claim.—2. In a life-saving apparatus, an enclosed vessel, an inflatable envelope disposed exteriorly of said vessel, inflatable extensions disposed on diametrically opposite sides of said vessel extending it longitudinally. Seven claims.

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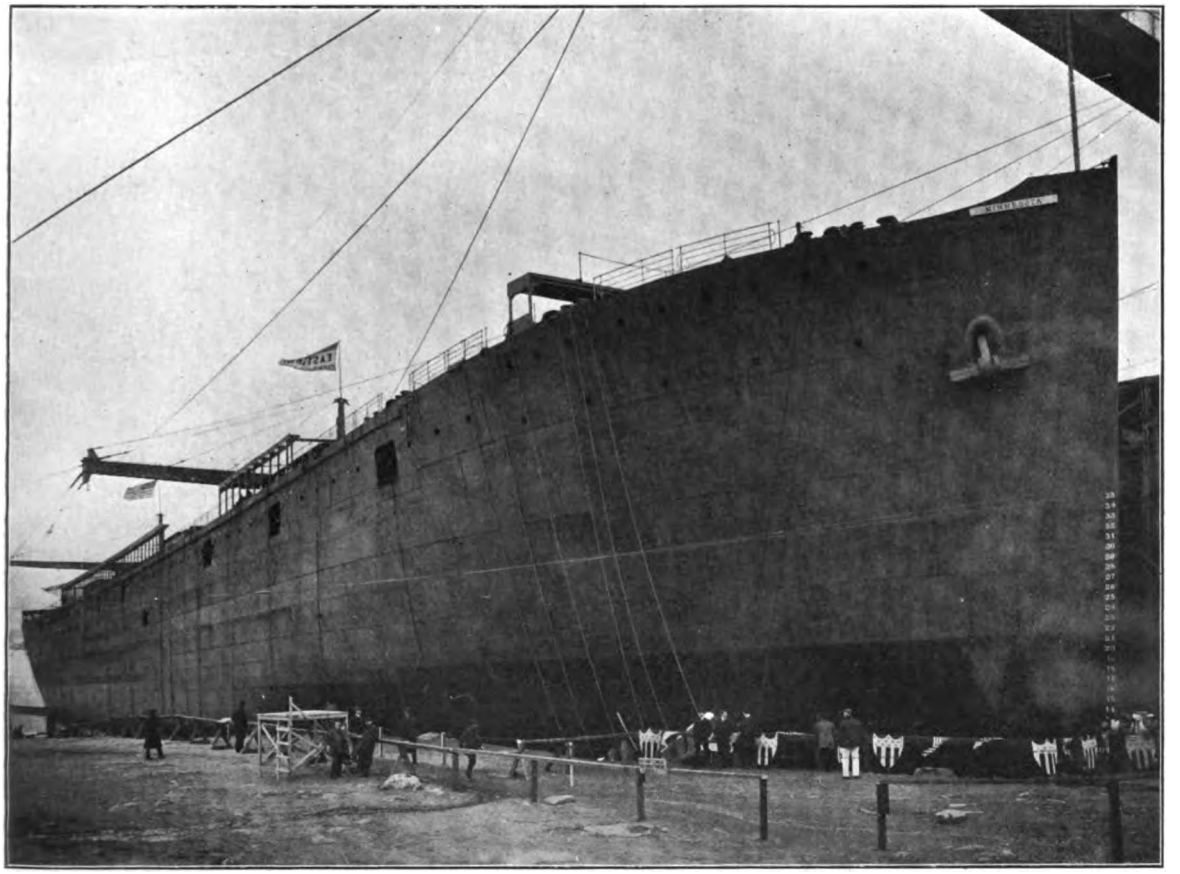
Marine Engineering

Vol. 8. NEW YORK, MAY, 1903. No. 5.

STEAMSHIP MINNESOTA, OF THE GREAT NORTHERN STEAMSHIP COMPANY, BUILT BY THE EASTERN SHIP-BUILDING COMPANY.

The Eastern Shipbuilding Company, of New London, Conn., launched on April 16, from its new yard on the Thames river, the first of the two great vessels it has been building for the Great Northern Steamship Company. As the ship started down the ways she was christened the *Minnesota* by Miss Clara Hill, daughter of Mr. James J. Hill. The launch in every respect was most successful, as a result of very careful arrangement of the construction of the ways, and all details incident to moving such a great bulk of steel as entered into the construction of this ship, and was made a memorable occasion from the presence of many distinguished men in shipping, railroad, and financial circles.



STEAMSHIP MINNESOTA BEFORE LAUNCHING FROM THE YARD OF THE EASTERN SHIPBUILDING COMPANY.
[Photographed specially for Marine Engineering by Enrique Müller.]

The yards of the Eastern Shipbuilding Company were fully described in the March (1902) issue of MARINE ENGINEERING, and suffice it to say that as laid out by the president, Mr. Charles R. Hanscom, have fully met the exceptional requirements.

When the contracts were signed for the two great ships now under construction, not only was it necessary to design and construct these vessels, but also to lay out and build a shipyard. The experience of Mr. Hanscom, who comes from a family of shipbuilders, and who was brought up from the technical school through the different departments of the shipyard to succeeding positions of responsibility, qualified him to undertake this work, a measure of the success of which may be judged from the present condition of these mammoth ships.

HULL CONSTRUCTION.

The *Minnesota*, and the *Dakota* soon to be launched, are intended to run between Seattle and Japanese and

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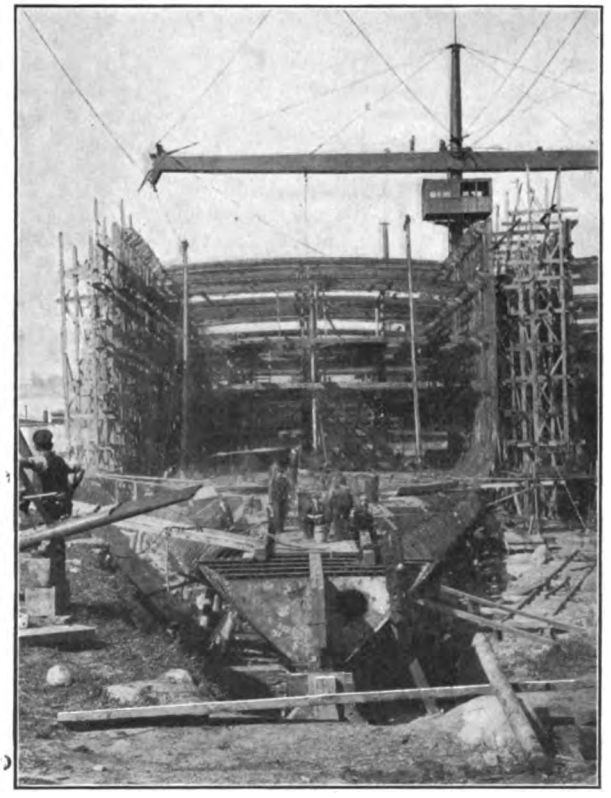
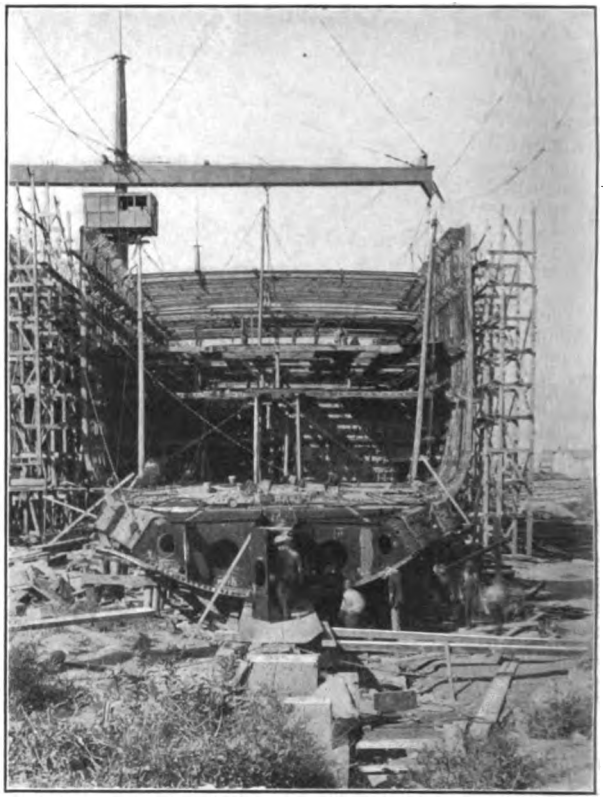
Chinese ports. They are the largest ever built in America, no other vessels touching them in size by several thousand tons. They are not remarkable as far as speed is concerned, being of the intermediate cargo and passenger type, but their passenger accommodations will compare most favorably with the largest Atlantic liners, and in freight-carrying capacity and displacement far exceed any vessel built in America. The vessels are 630 feet length over all and 73 feet 6 inches extreme beam. There are five complete decks in the hull proper and three decks in the superstructure or main house, and the nomenclature for these is, orlop, lower, 'tween, main, and upper which is the weather deck; and in the deck house are the promenade, bridge, and boat decks, with the navigating bridge above all. A double water bottom, 6 feet deep at the center line and 4 feet at the margin, extends from the forward to the after collision bulkheads, and twelve transverse bulkheads extend from side to side, six to the main deck and six to the upper deck. There is also a water-tight center-line bulkhead extending the entire length of the ship, fore and aft, running to the main deck. The plating of all bulkheads runs from 12 to 18 pounds, and is stiffened by 8 by 31 by .41-inch bulb angles.

There are several special features of construction, made necessary in a ship of these great dimensions. There are two vertical center keelsons, running the entire length, fore and aft, excepting at the extreme ends, where they run into one at the center line. In the water bottom the longitudinals are continuous and the floors intercostal. Extending from the forward boiler room bulkhead to No. 1 hatch, or a distance of 207 feet, is a pipe tunnel and emergency drain 9 feet high, built as shown in the midship section. One side of this tunnel is a continuation of one of the center keelsons, and on top of this extends the center-line bulkhead, which, as will be seen, is 18 inches off the true center line. Under the floor of the tunnel is the emergency drain, which is connected by valves to each of the forward compartments, and the valves may be operated from either the tunnel or the upper deck; thus, if any compartment is pierced, connection may be made by this drain to the pumps in the engine room and the water discharged at the rate of 25,000 gallons per minute. There is also means of escape from the tunnel at the forward end to the main deck. The piping to the compartments aft the engine room is laid through the shaft alleys, and a similar emergency drain fitted in each shaft alley.





BOW VIEWS OF THE TWO GREAT SHIPS AT NEW LONDON DURING CONSTRUCTION, SHOWING OVERHEAD TROLLEY SYSTEM.

The ships are classified for Lloyds' highest rating, and some of the principal scantlings are as follows:

Inner keel plate, 59 inches wide by 50 pounds; outer keel plate, 16 inches wide by 80 pounds; the frames amidships are 12 by 3 by 3 11-16 by 9-16-inch channels, split at the lower end, one half extending to the bottom of the margin plate and attached to the shell plating, and the other half being curved to the tank top as a reverse frame. At the ends there are frames and reverse frames, the former being 8 by 3 1-2 by 10-20 inch angles, and the latter 7 by 3 1-2 by 10-20 inch angles. All frames run to the upper deck; the spacing amidships is 30 inches

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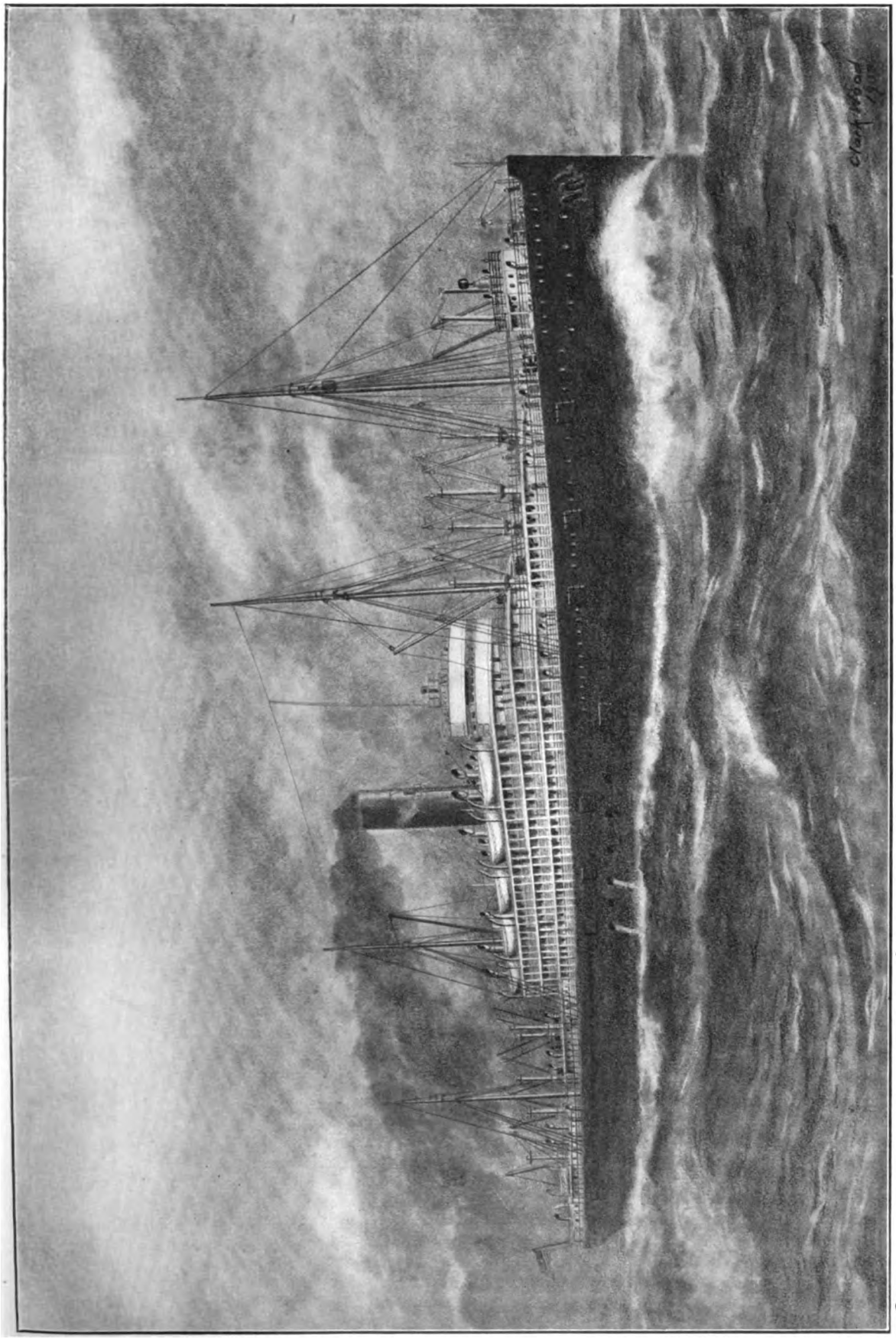

PASSENGER AND FREIGHT STEAMSHIP MINNESOTA, FOR ORIENTAL TRADE, WHICH THE EASTERN SHIPBUILDING COMPANY, NEW LONDON, CONN., IS COMPLETING FOR THE GREAT NORTHERN STEAMSHIP COMPANY.

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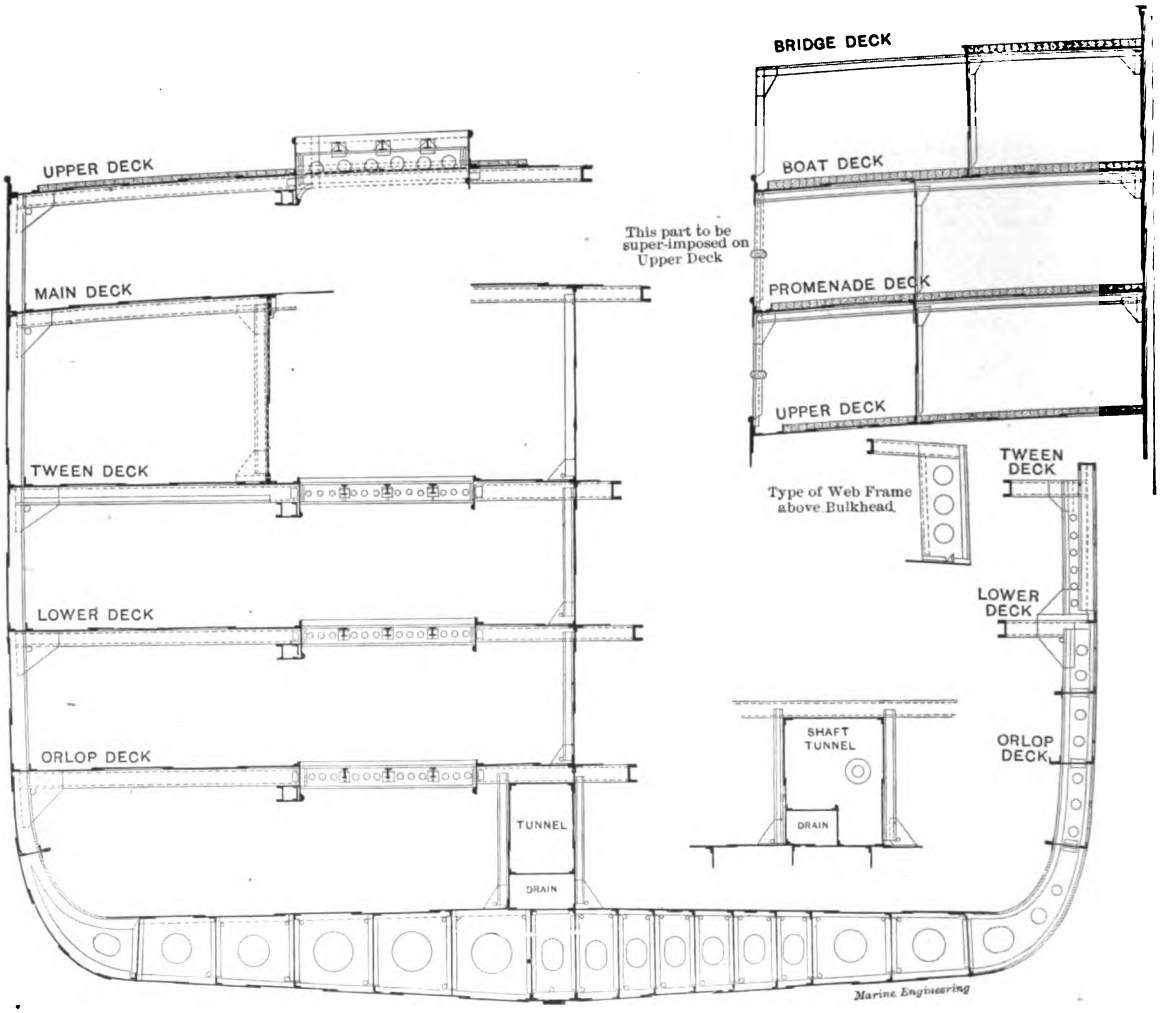
and at the ends 27 inches; and in the engine room are deep web frames 24 inches deep, while in the boiler room the webs alternate with the channel framing. The longitudinal keel bars are 5 by 5 by 15-20-inch angles.

The shell plating is run in in-and-out strakes, 19 strakes in all, the thickness being 17-20 inch amidships reduced to 13-20 inch at the ends, except for the sheer strake, which is 20-20 inch amidships and 13-20 inch at ends. There are really two sheer strakes, one at the upper deck and one at the second strake below, or at the main deck, and each of these strakes has a doubler for three-fifths length amidships.

The deck beams are 12 by 3 11-16 by 3 11-16 by 9-16-inch channels for all decks, except the main and upper, which are 10 by 3 11.5-20 by 3 11.5-20 by 11.5-20-inch channels.

In lieu of the ordinary pillars and stanchions, there is fitted a system of built-up girders and stanchions. The girders run almost continuously fore and aft at the outboard side of the hatches port and starboard. The girder is made up of 12 by 13-inch channels, with top and bottom plate, and is fitted below each deck. The stanchions are widely spaced and are also built up of 12-inch channels attached to the girder and deck by brackets and clips.

Both the stem and stern posts are steel castings, the former being in two pieces extending from forefoot to the upper deck, and the latter is in four sections and has bolted to it the propeller strut steel castings. The rudder is of cast steel in four pieces, bolted and keyed together, the bottom casting having an overhang forward, tending to balance the rudder; the stock is also of cast steel, 14 1-2 inches diameter, with a palm on its lower end, bolted and keyed to the rudder. There are six steel pintles, 6 3-4 inches diameter, with brass bushings, which may be renewed without removing the rudder. The complete weight of the rudder is carried by a roller bearing on the upper deck in the steering-gear house.



MIDSHIP SECTION OF THE STEAMSHIPS MINNESOTA AND DAKOTA.

The length of the main house is 172 feet on upper and promenade decks, 148 feet on the boat deck, and the chart room and wheel house on the bridge deck is 40 feet long. As will be seen by the midship section, these decks extend to the sides of the ship. The windows of all state rooms in this house are of rectangular shape and have sliding blinds and stained-glass screens and ventilating tops of the Adams and Westlake type. The other

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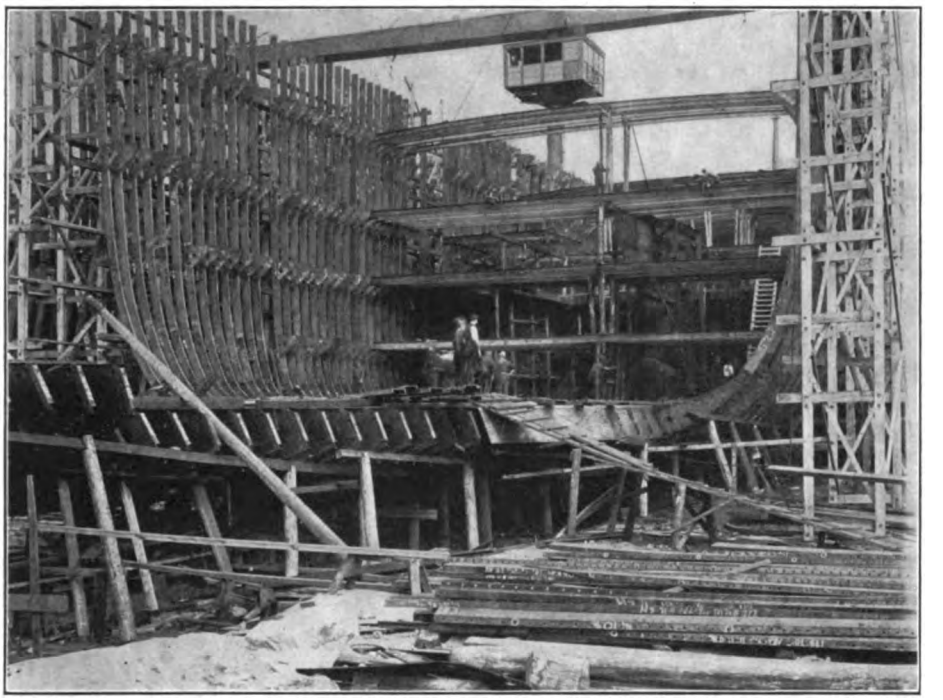
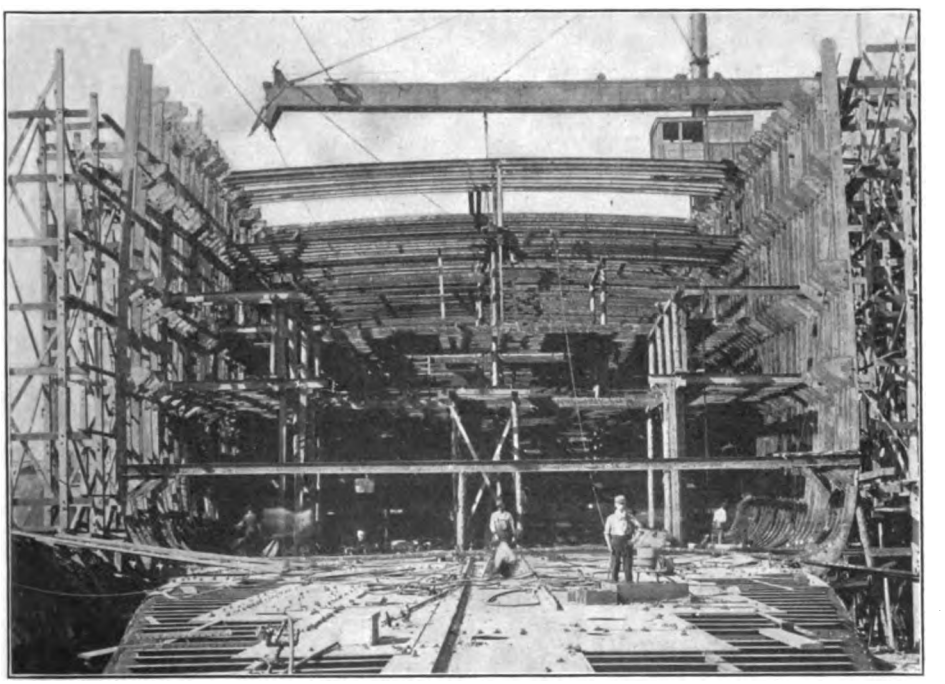
deck erections are a crew's house forward, the third-cabin house, which also contains the refrigerating machinery and is between the crew's house and the main house, and the steering-gear house aft. These will be referred to later.



ERECTING THE FRAMES ON THE DAKOTA, LOOKING AFT.



VIEW ON THE MINNESOTA, SHOWING TANK TOP AND FRAMING.

MACHINERY.

The propelling machinery of the two ships has been built at the works of the Midvale Steel Company, and is of more than usual interest, as the intention of the design has been to give maximum efficiency and endurance with

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minimum weight and cost. The main engines of each ship consist of two sets of three-cylinder vertical, inverted, direct-acting, triple-expansion engines with cylinders 29, 51, and 89 inches in diameter by 57 inches stroke, designed for 78 revolutions per minute and to develop about 4,800 horse power each with a steam pressure at the engine of 230 pounds; this is expected to drive the ship at 14 knots speed. The arrangement of the cylinders and valves is as follows, starting at the forward end: High-pressure cylinder, high-pressure piston valve, low-pressure cylinder, low-pressure double-ported slide valve, intermediate-pressure cylinder, and the intermediate-pressure piston valve at the after end of the engine. The sequence of cranks is as usual, namely, high-pressure, intermediate, and low-pressure. The engines are placed in separate water-tight compartments, driving twin screws turning outboard, the working platform of engines also being outboard.

The high-pressure piston has one piston valve, 17 inches in diameter; the intermediate cylinder, one piston valve, 32 inches diameter; and the low-pressure, one double-ported slide valve, 95 inches wide by 59 inches long, all valves having a common stroke of 10 inches. The intermediate and low-pressure valves are fitted with Joy's assistant cylinders, 6 3-4 and 8 3-4 inches diameter, respectively, while the high-pressure valve is partially balanced by having its upper portion enlarged in diameter. The piston valves take steam on the inside.

The cylinders and chests are in four separate castings bolted together; the high-pressure cylinder and chest, the intermediate cylinder and chest, the low-pressure cylinder and the low-pressure valve chest, each being separate castings. Distance pieces are placed between high and low-pressure cylinders and between intermediate cylinder and low-pressure valve chest, allowance being made for expansion. The high-pressure cylinder has an 11-inch diameter opening for steel steam pipe on front of chest, and exhausts into a cast-iron T-pipe 15 1-2 inches diameter, bolted to high-pressure chest at back, thence through a 15 1-2-inch copper pipe with a slip joint at intermediate chest. The intermediate cylinder exhausts through two rectangular passages, each 18 x 12 1-2 inches, made a part of cylinder casting, while the low-pressure cylinder exhausts through a 32-inch diameter copper pipe with a slip joint at condenser.

The cylinders are jacketed. A 2-inch copper pipe connected to throttle-valve casing supplies steam for jackets, the circulation of steam through jackets being continuous from one cylinder to the other, draining at low-pressure jacket, and the pressure reduced at intermediate and low-pressure cylinders. Copper pipes with brass castings and Leslie regulating valves connect the cylinders. The lagging of cylinders and chests is of steel galvanized, with vertical joints; bonnets have rolled diamond plates on top. The filling-in with non-conducting material is most thorough—bonnets, sides, and bottom, with all intermediate space and pipes, being thoroughly covered.

The pistons are of cast steel, coned, except the high-pressure, which is of cast iron, flat, and of hollow section. The framing is of three cast-iron inverted Y housings at back of engine, with six heavy wrought-steel columns at front, the housings carrying the guides, reversing engine, and brackets, and the columns carrying the handling, governing, and indicator gear. The framing is of such proportions as to be thoroughly stiff and rigid, obviating the use of any bracing beyond tying the engines together with athwartship ties at top of housings. The bed plate is of cast iron, box section, very deep, made in three sections; the bottom is made to suit the tank top of ship, being firmly bolted to same. The main-bearing caps are of cast steel lined with white metal, the bottom box of cast steel with a brass bush lined with white metal, and water circulation is provided through top and bottom boxes. There are two bearings to a crank.

The main valves are operated by Stephenson link motion, double-bar links, with eccentric rods 9 feet 9 inches centers. The reversing gear consists of a direct-acting steam cylinder, with oil cylinder on top, size 14 by 7 by 26 3-4 inches stroke, controlled by the usual floating lever with rod led to front of engine with lever and quadrant. The reversing shaft is 8 inches diameter, 23 feet 1 inch long, with cast-steel arms; reversing arms are arranged for linking in and out. There is also provided an oil pump for hand reversing, 2 1-8 by 4 inches stroke, of the single-acting plunger type.

The connecting rod is 10 feet 6 inches centers, 10 inches diameter at crank end, 8 inches at fork end. Crank end has brass bushes lined with white metal, 18 inches diameter, 20 inches long, while crosshead end has brass boxes each 10 inches diameter by 11 inches long. The crosshead block is 13 by 13 inches, journals 10 inches diameter by 11 inches long. The slipper is of cast steel, bolted to crosshead, faced with white metal; size, 24 inches wide, 30 inches long, and with astern surface two-thirds of ahead. The piston rods are 8 inches diameter in stuffing box, tapered in pistons and crossheads, 6 inches over threads at ends, total length 10 feet 9 1-8 inches. Katzenstein's metallic packing is used for both piston and valve-stem stuffing boxes.

The crank shaft is of the built-up type, in three interchangeable sections. Each section is 10 feet 5 1-2 inches long from coupling to coupling, pins and shafts 18 inches diameter with 8-inch diameter holes bored axially in same; pins and shafts are finished all over. The webs are machine finish only, figure 8 shape, 12 1-2 inches thick, 37 1-2 inches diameter at ends. Couplings 31 1-2 inches diameter, 4 1-2 inches thick, with 9 taper bolts 2 5-8 inches diameter at thread, tapering from 3 to 3 3-4 inches on 25-inch diameter pitch circle.

These crank shafts are so accurately finished that when placed on the inspection V blocks they were but 2-1000 of an inch out in alignment and diameters of the journals and pins. This accuracy in finish is characteristic of this company's work, as all measurements are made and checked with micrometers, the final inspection being made on an inspection bed specially provided for this class of work, and is within 1-1000 of an inch of perfect accuracy.

The thrust shaft is 18 1-8 inches diameter, 14 feet 4 inches long, with 9 collars 2 1-2 inches thick, 27 5-8 inches diameter. The thrust bearings are of cast iron with cast-steel horseshoes lined with white metal, and each shoe has water circulation, and collars of shaft also run in oil bath. Steady bearings are provided at each end.

The intermediate shafts are six in number, each 17 inches diameter, 22 feet 6 inches long, and two Verity

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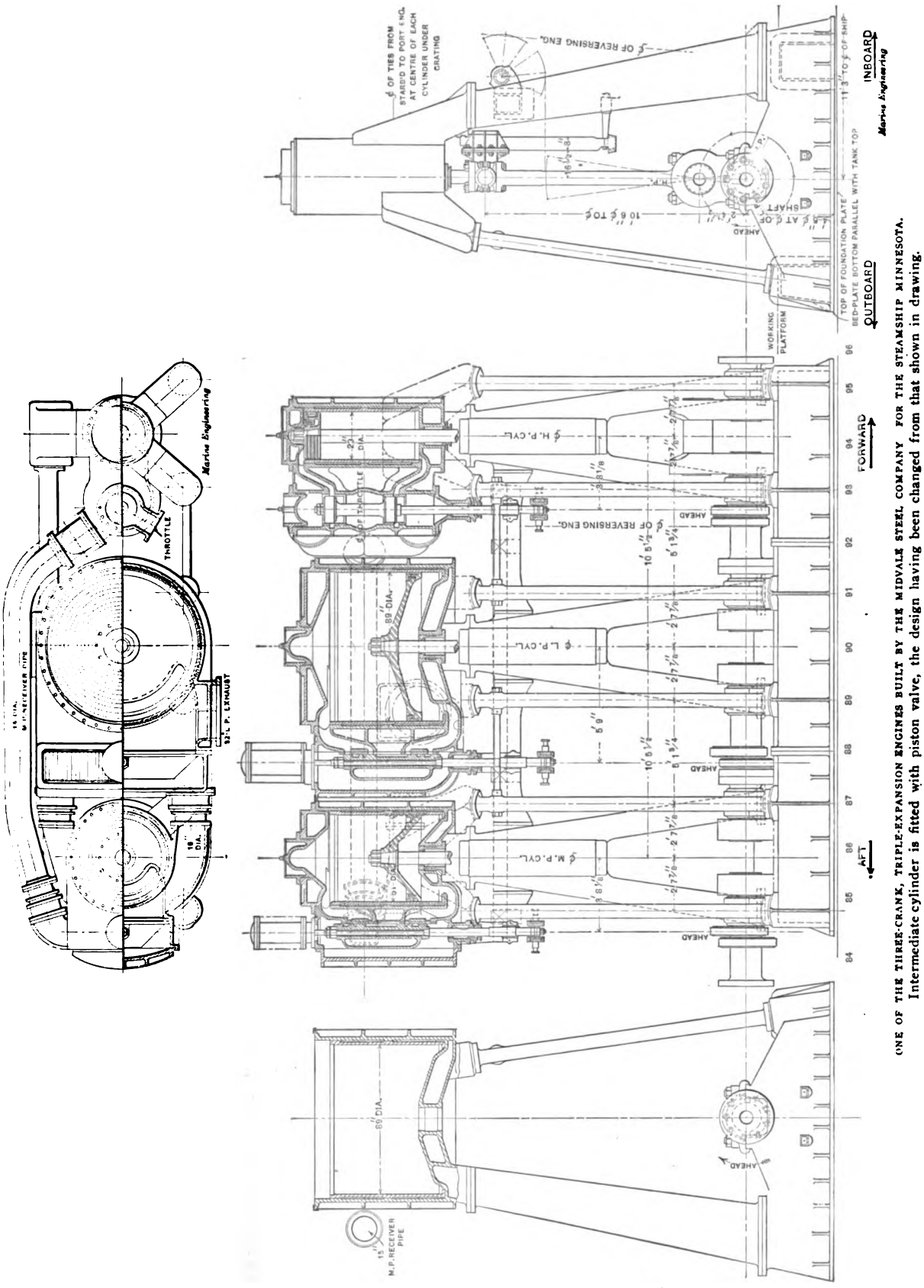

ONE OF THE THREE-CRANK, TRIPLE-EXPANSION ENGINES BUILT BY THE MIDVALE STEEL COMPANY FOR THE STEAMSHIP MINNESOTA.
Intermediate cylinder is fitted with piston valve, the design having been changed from that shown in drawing.

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flexible couplings are on each line of shafting, one coupling forward of stern tube and the other forward of shaft-alley forward bulkhead in thrust recess. Two separate lengths of shafting, each 7 feet 6 inches long, take these couplings, the after end of thrust shaft meshing with forward Verity shaft forming one, and the forward end of tail shaft meshing with after Verity shaft forming the other coupling.

The tail shaft is 19 inches diameter, 36 feet 9 1-4 inches over all, with brass sleeves for bearings, and covered with brass liners between the sleeves; the joints between liners being made male and female with a white-metal ring, calked. The total length of one line of shafting from forward coupling of the high-pressure cylinder to end of tail shaft is 232 feet 5 3-4 inches.

Steady bearings are of cast iron, lined on bottom with white metal, fourteen bearings on each line of shafting.

Each propeller is a true screw, three bladed, with cast-steel hub and blades of the following dimensions: Diameter 20 feet, pitch 22 feet 6 inches, developed surface each wheel 98.7 square feet, projected surface 81.6 square feet. The blades are secured to hubs by 3 1-4-inch diameter steel studs, 9 for each blade, holes ovaled, giving a range of pitch adjustment from 21 feet 6 inches to 23 feet 6 inches.

A complete oil and water system is provided, extending to all parts of the main engines. The oiling is by wick feed, from brass oil boxes on cylinders for main moving parts, separate boxes being fitted for each main bearing and eccentric, while eccentric-rod pins and links, reversing bearings, etc., have separate boxes of locomotive type. Water circulation is provided for guides, main bearings, and thrust-bearing shoes, sprays and pipes for all other parts, with a very complete system of cocks and swing joints. All piping is of brass.

The handling gear is located on column side of engine, operated from the working platform at crank pits. On the after column of the high-pressure cylinder is an 18-inch diameter hand wheel operating the stop valve, which is of the piston-balanced type, 11 inches diameter, bolted to the front high-pressure chest. The cock admitting steam to the balance piston is worked by lever at this same column. At the forward column of low-pressure cylinder are the levers for throttle valve and reversing engine. The throttle valve is of the butterfly type, 11 inches diameter, bolted to under side of stop valve. This valve is automatically controlled by an Aspinall governor which is carried on a special lever worked from the low-pressure crosshead. A disconnecting arrangement is provided for disconnecting the governor gear when in port, enabling throttle to be worked directly by hand lever.

On the after column of the low-pressure cylinder are the levers for operating the drain cocks, one lever for each cylinder. The cylinder cocks are 2 inches diameter, steam chest cocks 1 1-4 inches diameter, connected by separate levers to a 1 1-4-inch cold-rolled shaft led fore and aft at front of upper column feet. The operating lever for each cylinder opens or closes the cylinder and chest drains of that cylinder simultaneously. All drains lead to condenser.

The condenser is of sheet steel 7-16 inch thick, 6 feet 8 inches inside diameter, made from three sheets circumferentially, stiffened by three 3 1-2 by 3 1-2 by 1-2-inch angles with two bounding angles 3 1-2 by 3 1-2 by 13-16 inches.

The heads are of cast iron, the tube sheets 1 1-8 inches thick, of rolled brass; supporting plate, 3-8 inch thick, of rolled brass. There are 2,456 7-8-inch tubes, 12 feet long between tube sheets, giving 6,750 square feet of cooling surface. The circulating water is passed twice through the condenser, being supplied by a 20-inch centrifugal pump delivering 8,000 gallons per minute, and driven by a 10 by 20 by 10-inch vertical compound engine of 80 horse power. One 6 by 6 by 6-inch vertical engine, to run at 300 revolutions per minute with 100 pounds steam pressure, is provided for turning both main engines, being connected to same by an athwartship length of shaft, in two pieces, with clutches provided on each end of turning engine crank shaft, fitting into corresponding clutches on connecting shafts. These clutches are so arranged and operated by a hand lever that only one main engine at one time can be turned over. This athwartship shaft drives a worm and wheel (ratio 30:1) at each main engine, this latter wheel being keyed on a vertical shaft with a worm on upper end, which worm meshes into the turning wheel on main engine shaft (ratio of last worm and wheel 60:1).

Provision is made for hand turning; the turning engine is operated by a change valve. Attached to forward coupling of main engine crank shaft is a cast-steel disk with a pin driving two single-acting, plunger bilge pumps, each 6 inches diameter, 10 inches stroke.

The high grade of steel work turned out by this company is of special mention. All the steel forgings and castings are thoroughly annealed, tested, and every requirement fully met.

Of the above machinery all shafting is of high-grade open-hearth steel, oil tempered and annealed, 80,500 pounds tensile strength, and 46,000 pounds elastic limit. The crank webs, connecting rods, and other main forgings are of open-hearth steel, 70,000 pounds tensile strength, 40,000 pounds elastic limit.

The weights of machinery for each engine are about as follows:

Cylinders, housings, and bed plate	350,650	pounds
Thrust and steady bearings	20,000	"
Stern tube and B. H. stuffing boxes	17,800	"
Columns	23,500	"
Crank shaft and one complete line of shafting	169,000	"
Connecting rod and main reciprocating parts	38,500	"
Valves, links, and gear	24,000	"
Reversing engine, shaft, and gear	8,600	"
Indicator, governor gear, grating, hand rails	4,250	"
Copper piping	2,050	"
Brass piping, casting, and valves	2,250	"
Lagging and covering	10,300	"
Bilge pumps	875	"
Propeller	42,000	"
Turning engine and gear	4,840	"
Spares	38,000	"
Condenser	49,850	"
Circulating pump	12,565	"
Total for one engine	819,030	"

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BOILERS.

Each vessel will have 16 Niclausse water-tube boilers, built by the Stirling Company, the arrangement being shown in the drawing on page 231. The sizes and surfaces are as follows:

Four	19-element	.....	11,244	H. S.;	302	G. S.
Four	19	"	10,656	"	286	"
Two	17	"	4,032	"	135	"
Six	15	"	13,332	"	357	"
	Total	.....	39,264	"	1,080	"

this end fits into a tapered hole in the rear face of the header, while the other end of the tube is sealed by a steel cap. A sleeve with a flexible joint is fitted into the front end of the tube through both headers, the tapered surface fitting the front face of the header. This sleeve also contains a smaller sleeve, which holds the inner or circulating tube, of less diameter, which is inserted almost the entire length of the generating tube. The sleeves are held in place by a dog and can be very easily removed and replaced. The water circulation in these boilers is positive. The feed water enters a tray in the

NICLAUSSE BOILERS FOR THE MINNESOTA AND DAKOTA, ERECTED IN THE TESTING SHOP OF THE STIRLING COMPANY.

The boiler room, as the engine room, is divided by a center-line bulkhead, eight boilers in each room, arranged fore and aft, with two thwartship fire rooms.

The detailed drawing of the boiler is given on page 230, and a view of the boilers mounted on the testing floor of the Stirling Company is shown on this page. The boilers are to carry a working pressure of 250 pounds, and when set up complete were tested to 500 pounds hydraulic pressure. The boiler consists of a steam drum and a series of headers, into which tubes are fitted. The field tubes, set at an angle of 6 degrees to the horizontal, are arranged as in the sectional drawing, and each header is divided into two compartments. The outer, or generating tubes, are upset at one end to a diameter slightly in access of that of the tube itself, and

drum, is heated to the temperature of the steam, and impurities are precipitated. Overflowing the drum, it descends the front compartments of the headers and back through the inner tubes to the extreme end, where it turns and passes to the front through the only space between the tubes. The mixed water and steam then pass upward through the angle compartments of the headers and discharge into the drum. The drums are 45 inches in diameter, 15-16 inch thick, while the generating tubes are of seamless cold-drawn steel, 3 1-4 inches outside diameter and No. 6 B. W. G.; the circulating tubes are 1 19-32 inches outside diameter by 21 B. W. G. All the material used in the boilers, and their final acceptance under steam, are subject to the approval of Lloyds.

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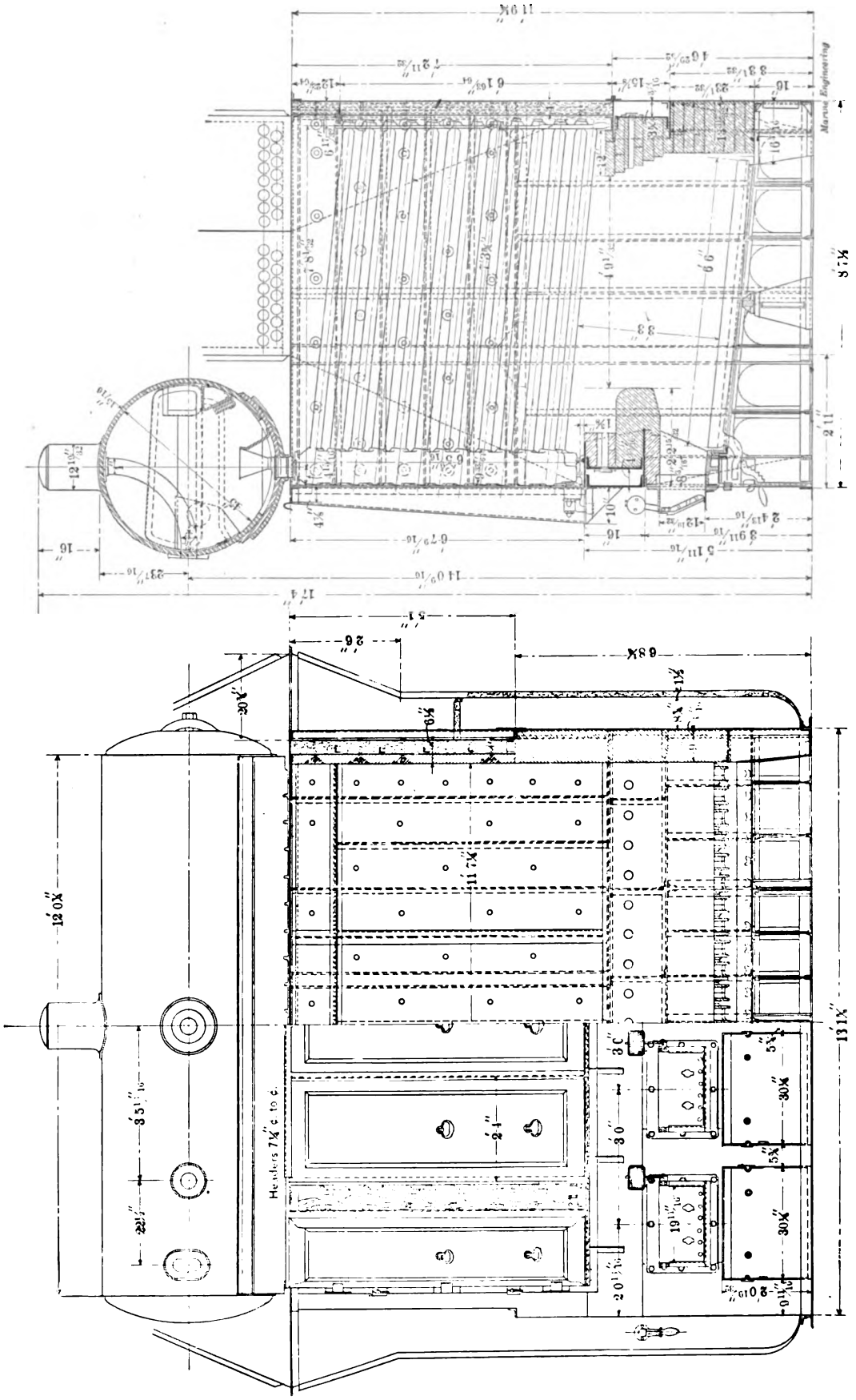

ASSEMBLY DRAWING OF ONE OF THE SIXTEEN NICLAUSSE WATER-TUBE BOILERS FURNISHED BY THE STIRLING COMPANY FOR THE MINNESOTA. THE DAKOTA IS EQUIPPED WITH A BATTERY OF THE SAME SIZE.

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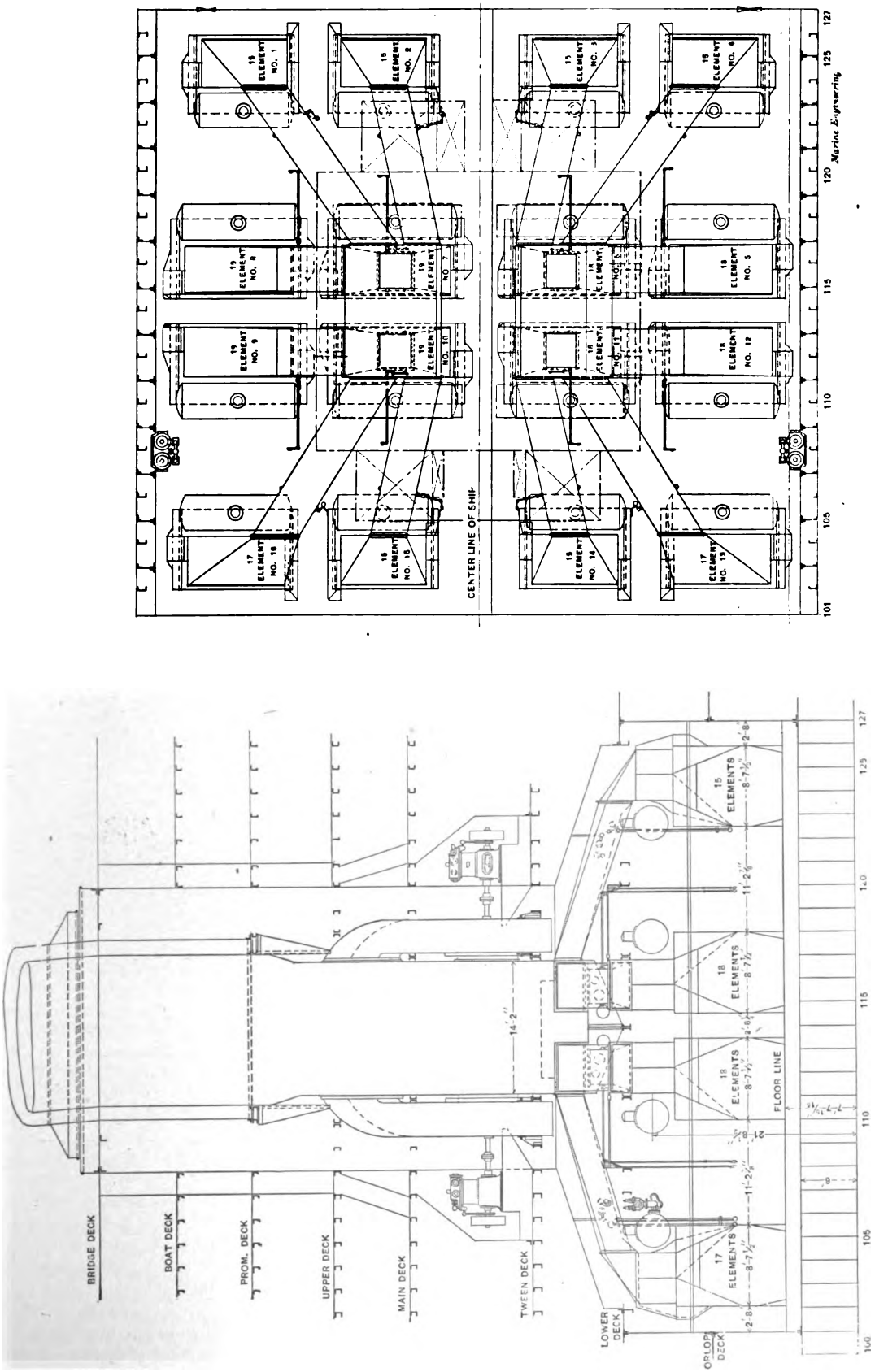

ELEVATION AND PLAN OF BOILERS AND UPTAKES ON THE MINNESOTA, BUILT BY THE EASTERN SHIPBUILDING COMPANY.

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A donkey boiler is placed on the deck and is of the vertical tubular type, 5 feet in diameter, 10 feet 6 inches high, and has a grate surface of 16 square feet and a heating surface of 692 square feet, furnishing steam at 150 pounds pressure. The ship has but one stack, elliptical in form, 16 feet by 13 feet, and 124 feet 10 inches above the grates.

PUMPING OUTFIT.

All the steam pumps used, including the auxiliary and main condenser air pumps, are of the Blake type. There are two circulating pumps of the usual centrifugal type, each driven by an independent compound engine with cylinders 10 and 20 inches diameter by 10 inches stroke, built by the Morris Machine Works. A list of the pumps, including those of both engine rooms, is as follows:

Two vertical simplex cross-connected air pumps, each pump with two 10-inch steam cylinders, two 20-inch pump cylinders, common stroke of 16 inches.

Two main feed pumps, 18 and 10 by 18 inches, vertical simplex type. Two auxiliary feed pumps, vertical compound duplex, the steam cylinders being 12 and 18 1-2 inches diameter and the water cylinders 8 inches diameter, all with a common stroke of 12 inches. The water is raised from the hot well by two pumps, 8 inches, 12 by 12 inches, of the vertical simplex type, and lifted into the feed-water jet heaters, from whence it is taken by the main feed pumps to the boiler.

There are two horizontal compound duplex ballast pumps, 8 inches, 12 and 14 inches, by 18 inches stroke. The fire pump is of the same type, the dimensions being 14 inches, 20 and 14 inches, by 18 inches.

There is one general service donkey pump, with compound duplex pistons, 14 inches, 20 and 10 inches, by 12 inches stroke.

The salt-water sanitary pump is 8 and 12 by 10 1-4 inches by 10 inches, compound duplex, and the fresh-water sanitary pump is a vertical compound duplex with cylinders 5 1-4, 7 1-2, and 7 1-2 inches by 6 inches. There is an auxiliary sanitary horizontal duplex pump, 10 and 10 1-4 by 10 inches. The fresh-water pump is of the vertical simplex type, the dimensions being 4 1-2, 6 by 6 inches.

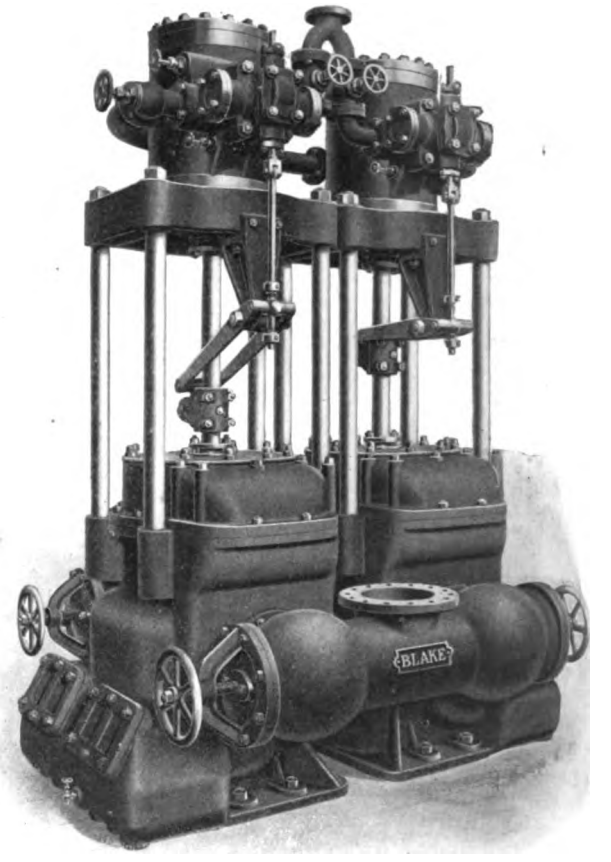
There is one oil pump, 3 and 2 inches by 3 inches, of a special horizontal duplex type, and the test pump of the same type used for donkey boiler feed is 6 and 2 3-4 inches by 6 inches stroke.

The other pumps installed are as follows: One evaporator lift pump, 3 by 2 by 3 inches, special duplex; two crank-pit oil pumps, 2 by 1 1-4 by 2 3-4 inches, special duplex; two refrigerator brine pumps, 4 1-2 and 6 1-2 by 6 by 7 inches, horizontal compound simplex; one air-compressing pump for potable water tank, 6 by 6 by 7 inches, vertical simplex; and two combined fresh- and salt-water distillery pumps, 4 1-2 by 3 3-4 by 3 3-4 by 6 inches, horizontal simplex.

There are two auxiliary air and circulating pumps, 12 inches steam by 14 inches air by 14 inches water by 12 inches stroke, of the horizontal simplex type, having a Wheeler Admiralty condenser with about 800 square feet of tube surface mounted on top. There is also a supplementary auxiliary air and circulating pump, 6, 8, and 8 inches by 7 inches stroke, of the same type, mounted on Wheeler condenser with 250 square feet of tube surface.

There are four single-acting horizontal bilge pumps, 6 by 10 inches, two being connected to each of the main engines on the forward end of the engine bed plate.

The feed pumps, located in each of the boiler rooms, have a capacity of 17,000 gallons of water per hour, and each is capable of supplying the water for 7,000 horse power. The ballast pump is connected to act as an auxiliary circulating pump, and the fire pump, placed under the condenser in the port engine room, has practically a universal suction and discharge, as it is connected with all the tanks and bilges and is fitted to act as an auxiliary ballast pump. The capacities of some of the pumps are as follows: Two ballast pumps, 300



VERTICAL SIMPLEX AIR PUMP FOR THE MINNESOTA.

tons each per hour; one fire pump, 300 tons per hour; donkey pump, 280 tons per hour; salt-water sanitary, 150 tons per hour; fresh-water sanitary, 50 tons per hour; auxiliary sanitary, 150 tons.

The main independent air pumps, one of which is here illustrated, are built without any suction valves whatever. The elongated air pistons, passing central ports located on the suction side of the cylinders, perform the same service as suction valves. The air pistons, having no valves (such as the buckets of a regular single-acting air pump possess), can approach the cylinder heads within one-eighth of an inch, consequently the clearance space is reduced to a minimum—an important feature in securing high vacuum-forming efficiency. These air pistons are cast hollow and filled with water-excluding material, having but little weight and requiring no pack-

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ing. The discharge valves at top and bottom are easily accessible.

As shown by the engraving, both the steam cylinders and air cylinders are provided with valves, cocks, and connections, so that either side can be run separately, should occasion require, thus practically providing a spare pump. The time required to change from running both sides together to running one side separately is less than one minute. Another advantage possessed by these pumps is their exceedingly light weight—about half that required for ordinary connected air pumps of the single-acting type.

One of the novel features in the pump equipment is providing a special salt-water pump to supply the water for a portable swimming pool that can be readily set up on the main deck during favorable weather, thus affording passengers the luxury of a daily salt-water plunge bath when the weather is favorable. This swimming pool is constructed of water-proof canvas arranged in a suitable manner, and will have a capacity of many tons of water.

In each engine room is a feed-water filter, made by the Blackburn Smith Company, capable of filtering all the feed water when the boilers are working under forced draft. The filters on the fresh-water sanitary system are furnished by the James Reilly Repair and Supply Company.

Besides the two main condensers there are four auxiliary condensers, furnished by the Wheeler Condenser and Engineering Company.

AUXILIARIES.

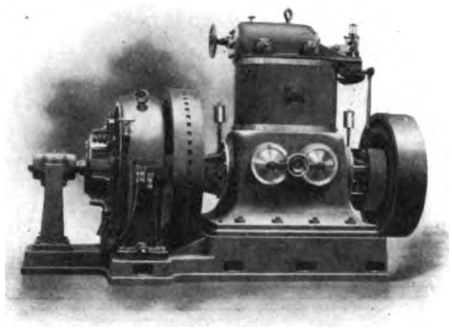
The evaporating plant is very large and complete, and consists of four evaporators, two distillers or condensers, two feed-water heaters, and one filter. It is arranged to be operated in single, double, triple, or quadruple effect. The evaporators, made by Williamson Brothers, are located in the forward ends of the engine rooms at the level of the engine-room floor. Connection is made so that steam from either the intermediate-pressure receiver or the auxiliary steam line, in which the steam is at 150 pounds pressure, may be connected to the evaporator. The exhaust from the evaporators is led to the low-pressure receivers.

A system of mechanical draft is installed in the boiler rooms, there being four 9-foot fans, each connected to a Westinghouse compound engine with 9 and 15 inches by 19 inches cylinders, elsewhere described. Induced draft is used, the fresh air being drawn through heaters in the uptake, through the boilers, round the air heaters, and is exhausted by the fans into the base of the stack.

Both steam and electric steering gear is installed, the steam being used for emergency and the electric for ordinary service. The gear and engine were made by Williamson Brothers, and are the same type as used in the White Star and Atlantic Transport Line ships. Both gears are directly attached to the quadrant in the steering house aft. The arrangements for steering are very complete. The chart and wheel house is placed at the forward end of the bridge deck, the wheel house containing wheel and compass. Immediately forward of this is a steel screen, extending under the full front of the deck. Stairs lead from here to the navigating bridge above, which also has a wind screen entirely around it. Behind this screen are located the engine telegraph, steering telegraphs, docking telegraphs, whistle operators, etc., also a complete officers' telephone communication.

ELECTRICAL EQUIPMENT.

The electric-generating outfit, which is very complete indeed, is located in the forward end of the engine room on a platform at the level of the orlop deck. There are six direct-connected Westinghouse generators, each of 75 K. W., driven by a Westinghouse compound vertical engine, 11 and 19 inches by 11 inches stroke. Each generator is a 6-pole machine, furnishing direct current at 110 volts when making 300 revolutions a minute. The Westinghouse engine, as generally known, is single-acting, taking steam on the downstroke only. The cylinders are cast together, and the horizontal steam chest is lined with a hard-iron bushing, which may be ringed. One piston valve controls the admission and exhaust of steam to both these cylinders and is packed with four springs. The pistons are of a trunk pattern and each



GENERATING SET FOR THE MINNESOTA.

is fitted with a pin, corresponding to a crosshead pin in other engines, with which the upper end of the connecting rod engages. The pins are case-hardened and accurately finished to gage. The pistons are packed with cast-iron spring rings. The main bearings consist of two cast-iron shells lined with babbitt and the lower half adjustable. There is also a center bearing between the two cranks, which is also adjustable. The connecting rod consists of a continuous forged strap, which is fitted with brasses at top and bottom, and the lower box is held in place by heavy bolts, and the inner halves of the upper and lower boxes are held apart by a forged steel strut or distance piece. The crank shafts are forged in one piece from open-hearth steel. The cranks revolve in a closed case, and, at the bottom, dash through oil or water, and thus carry lubrication to all moving parts. A Rites governor acts directly on the main valve.

The electric-light installation consists of about 1,300 lights, distributed throughout the ship, and a powerful 24-inch searchlight, of the General Electric make, placed on the forward lookout bridge. This light can be operated from the navigating bridge by an electric or hand gear. All electric fixtures were furnished by Page Brothers and Company. The powering and lighting is on the three-wire system, and several switchboards are conveniently placed throughout the ship.

Motor drive is used for the refrigerating engines, cargo winches, ventilating fans, and warping capstans, which will be described under the succeeding headings.

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REFRIGERATING PLANT.

The refrigerating plant referred to above is very ample, and is in duplicate sets consisting of two 30-ton marine ammonia compressors furnished by the American Linde Refrigerating Company. Each compressor is driven by a 75-horse-power direct-connected General Electric motor, mounted on a wrought-iron bed plate which contains the ammonia condenser coils. The coils are galvanized and so built that all points are on the outside of the condenser, in full view of the attending engineer. The plant also consists of two brine refrigerators, two air coolers, one ice-making tank, and one water cooler for cooling the filtered water which is supplied to the drinking fountains throughout the first-class accommodations. The entire plant is located in a deck house forward, as shown in the inset drawing.

The brine refrigerators are circular in form and contain the refrigerator coils. The special feature of the plant is the Linde patent air cooler, by which the temperature of the refrigerating holds is regulated. Each cooler contains a number of pipes, through which is passed the cooled brine. The brine is then sprayed over these pipes, and the air, which is drawn from the holds by electric-driven blowers, is forced along the outside of the cold pipes and through the spray. Thus the air is not only cooled but thoroughly washed by the brine, which also absorbs the impurities. The air is then delivered back into the hold dry and purified.

Besides the cooling of the holds which are for carrying cargo, the plant will also cool the different insulated chambers used for storing ship's provisions. As the machinery is supplied in duplicate, every protection has been taken to avoid a complete breakdown.

VENTILATION.

The system of ventilation in these vessels is very complete and efficient and comprises a fresh-air supply and an exhaust system. Fresh air is passed over heating or cooling coils for winter or summer service, respectively, and delivered into the passages and hallways, while the exhaust system draws the air from the state rooms and other parts of the vessel. These heaters and coils are furnished by Joseph McCreery. Besides this mechanical ventilation, there is fitted in all the cabin spaces a complete system of natural ventilation. This system is also used for ventilating the cargo and coal spaces. The entire problem of ventilation has been worked out in great detail, there being no less than seventy-two motor-driven blowing and exhausting fans, furnished by the New York Blower Company. These fans are direct-connected to Westinghouse motors.

ANCHORS, WINDLASSES, ETC.

The anchor-handling and warping appliances consist of a specially heavy Hyde windlass operated by a vertical compound engine placed on the forecastle deck. The windlass has two wildcats for handling 3 3-16-inch stud link Lebanon chains and two niggerheads. These wildcats are driven by two separate vertical shafts which extend through the upper deck and may be rotated together or independently. Two extra heavy chain stoppers of the navy type are fitted, also a capstan on each side of the windlass, operated by the windlass engine. Two similar capstans are fitted aft for warping the ship and are electrically driven by General Electric motors. There are three stockless anchors, supplied by the Admiral Anchor Company, their weights being respectively 16,800 pounds, 14,000 pounds, and 12,230 pounds. The chains above referred to are the heaviest ever made, sold by the Newhall Chain Forge and Iron Company, and the weight of the anchors, chains, etc., amounts to the great figure of 130 tons.

The life-saving appliances include belts, buoys, rafts, and boats. There are 15 metallic lifeboats, one metallic launch with alco-vapor motor, one wooden rowboat, and five metallic rafts.

For the purpose of extinguishing fires in the hold, steam pipes are laid into each cargo space; the controlling valves for same, being located on the upper deck, are at all times accessible. For the passenger spaces water service is provided for this purpose, and large escape ports are fitted below deck for carrying off this water.

COAL BUNKERS.

The cargo and coal capacity of these vessels is very large, and well shown in the accompanying plans. The coal bunkers are arranged to be self-trimming by means of sloping bulkheads, the after boiler-room bulkheads sloping about ten frame spaces, and the forward boiler-room bulkhead sloping forward about thirteen frame spaces, extending to the upper deck. The space between the main and upper decks is arranged to be used for either cargo or coal, and the length of this space on the main deck is about 120 feet. Coal chutes lead from these spaces directly to the fire rooms. The capacity of the trimming bunkers is over 4,000 tons, and in the reserve bunker space contiguous to the boiler rooms 2,000 tons of coal may be carried in addition.

CARGO SPACE.

The arrangement of the decks and hatches may be followed in the drawings on the inset, and in the drawing of the upper deck is given the layout of the cargo-handling appliances, showing the position of masts, booms, winches, and hatches. It will be seen that forward of the main house there are four hatches for cargo. The forward hold, just aft of the crew's house, is entirely devoted to cargo on each of the four decks. The four forward booms on the foremast serve this hold, the hoists being driven by four winches. The arrangement is such that one boom remains over the hatch, while the other swings over the side and brings the cargo over the hatch, where it is lowered by the stationary boom. The booms rest on a platform on the mast about 8 feet 6 inches above the deck. The hold aft of this is again entirely for cargo, the four after booms on the foremast and four winches operating it.

The next space is the refrigeration space, containing a silk room and an air-cooling room. The hatch above the upper deck is trunked through the second-cabin house. At the after corners of the house are two derrick posts, each with two booms, which handle the cargo in this space. Aft of this is a very large hold, designed for large and heavy cargo. The orlop deck is discontinued in way of this hold, giving a clear height above the tank top of 18 feet. The four booms on the mainmast and four winches operate this hatch. Besides this, there is a large 50-ton boom, which steps

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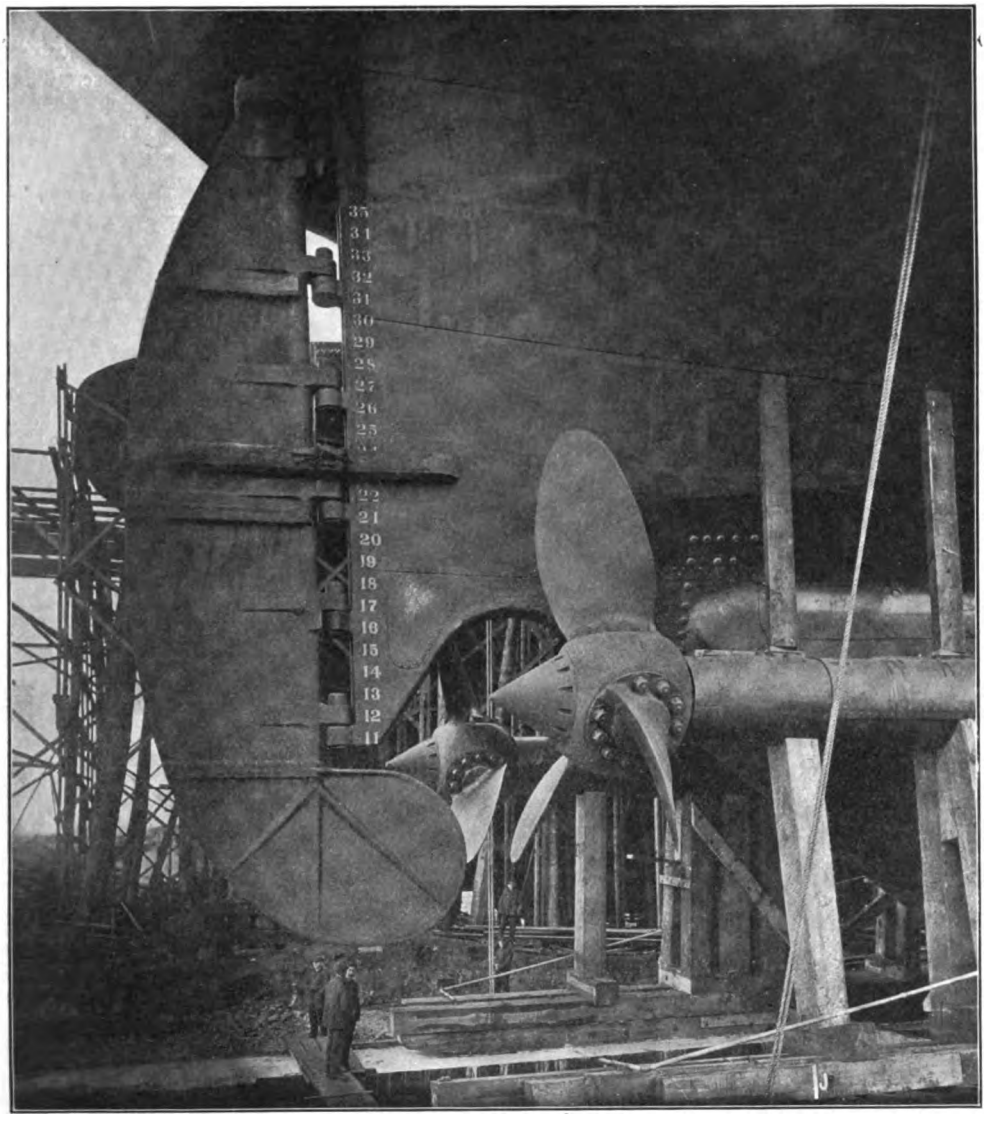
just forward of the mainmast on the upper deck, for handling heavy cargo. Two winches are arranged so they can be coupled together to operate this boom.

The next hold is almost entirely devoted to ship's provisions and use as a reserve coal bunker.

Aft of the main house there are four holds, all of which are entirely for general cargo. The one just aft of the house is operated by four booms on the mizzenmast and four winches. It is arranged so that a boom can be stepped on the fore side of the mizzenmast and swung over the engine hatch on the bridge deck. For the hatch aft of this there are two derrick posts, each with two booms and four winches. The other two hatches are operated by eight booms on the jiggermast, four on the fore side and four on the after side. A 30-ton boom steps on the forward side of the mast on the upper deck. All the masts step on the 'tween deck. On the bridge deck there are four small 1-ton booms and posts for handling coal. They are arranged to swing over the side and to the coal trunks. The winches operating these can be used for handling the boats. The booms are lowered into rests when at sea. It will be seen that there are 38 cargo winches, all of which were furnished by the Lidgerwood Manufacturing Company. The winches are driven by General Electric series-wound armored motors, each with a controller of the railroad type. The winches are of the following capacities: Twenty-six 25 horse power of 3,000 pounds capacity each; eight 40 horse power of 5,000 pounds; one of 7,000 pounds; two of 10,000 pounds; and one of 14,000 pounds.



CAST-STEEL RUDDER AND PROPELLERS OF THE STEAMSHIP MINNESOTA.

[Photographed specially for Marine Engineering by Enrique Müller.]

PASSENGER ACCOMMODATIONS.

The passenger accommodations are very commodious and are found on the main, upper, promenade, and boat decks. The crew accommodations are on the main deck in the fore peak and the forecastle deck—a short deck in the fore peak between the main and upper decks.

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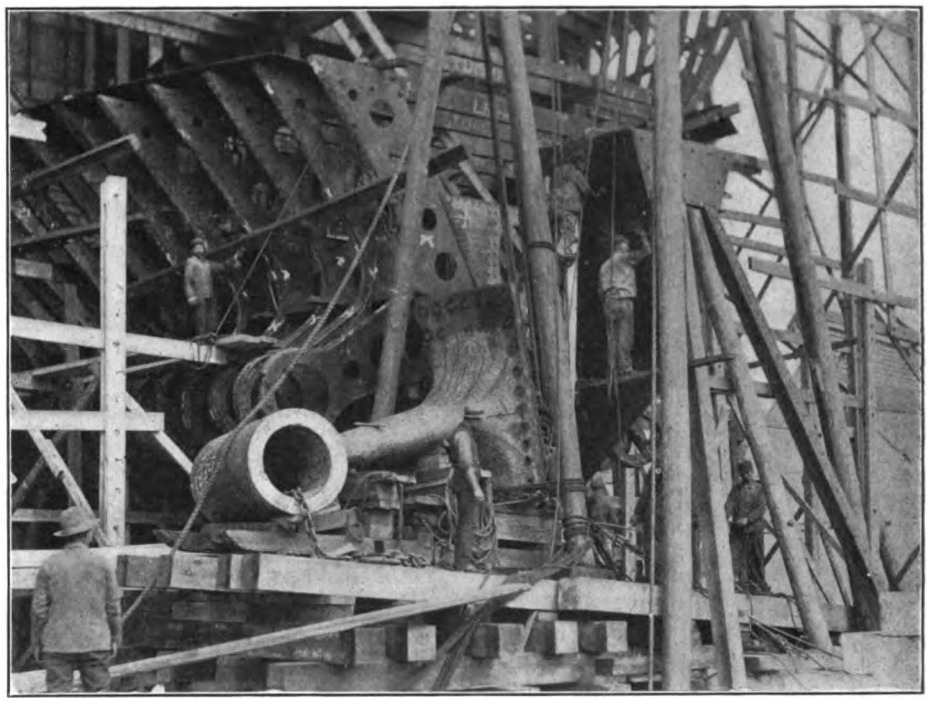
There are accommodations for 172 first-class passengers, 111 second-class, 68 third-class or white steerage, 1,067 steerage, and 1,377 troops, and a crew of 240 men. On the bridge deck forward are the chart room and wheel house and quarters for ship's officers. The pilot house is in the forward end, and leading from this is the chart room and captain's sitting room, while still further aft are the captain's state room and bath. The pilot house is finished in wainscoting of dark-stained cherry, the upper paneling being of quartered oak. The chart room and captain's sitting room are finished in cherry and oak, with dark reddish brown upholstery. The state room has a fixed bedstead and a wardrobe, and the cabin a table, upholstered seat, roll-top desk, chairs, etc.

The first-class passenger state rooms are found on the upper, promenade, and boat decks. In the forward end of the main house on the upper deck is the dining saloon, extending the full width of the house, with a seating capacity of 140. This room has dark, rich mahogany side paneling, rectangular windows with mahogany sliding shutters; also stained-glass windows with ventilators above lights. The ceiling and beam capping are of white staff; the floor is hard wood, carpeted between tables; the furniture is mahogany, and the furnishings of old-gold curtains, draperies, and upholstery.

Just abaft the dining saloon is the main hall, with grand staircase leading to the hall and state rooms above on the promenade deck. Aft of this, along the sides of the house, are state rooms. In the center of the house and forward of the boiler casing are commodious lavatories; forward of this, extending to the staircase, is the pantry.

The library and ladies' sitting room are in the forward end of the main house on the promenade deck, just above the dining saloon, the library being on the port side and the ladies' room on the starboard. The ladies' room is paneled with selected maple, with occasional light gold decorations, while the ceiling is of staff, delicately tinted. The floor is of polished maple and covered with a number of rugs. The upholstery is of dark olive green, with draperies of lighter shades of green, and the windows have sliding maple shutters, also stained-glass shutters of attractive design. The room has a large open fireplace, numerous cozy corners, and a grand piano with a maple case. The library is finished with side paneling of mahogany, and all the furniture is of the same wood, upholstered with a dark, rich shade of leather, tufted; the ceiling is again of white staff and the floor is red and white interlocking rubber tile.



CAST-STEEL PROPELLER STRUT BEING ERECTED IN PLACE ON THE MINNESOTA.

A nursery, or children's play room, is located on the promenade deck between the engine casings, and is finished with dark-stained cherry wainscoting; the upper side paneling is also of cherry, natural finish, with selected panels. The ceiling and beam capping are of white finish and the furniture is dark-stained cherry. The floor is carpeted with a dark, rich, figured carpet. Round air ports in the engine casing are fitted with ground, figured glass, and at the after end are rectangular lights with shutters and ventilators.

The remainder of the house on this deck is devoted to state rooms. A staircase in the hall leads to a large social hall on the boat deck, which is almost entirely given over to state rooms. There are several commodious suites, consisting of bed room with large, double brass bedstead and upholstered chairs and seats; this opens

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into a sitting room with upholstered extension sofa, seat, table and chairs, and this in turn leads to a bath room. Simplex electric heaters are fitted in all first-class state rooms and public rooms.

In the after end of this house, just forward of the engine casing, is the smoking room, extending the full width of the house, and in the forward end is an enclosed bar. The side paneling of the smoking room is quartered oak, natural finish, with rosewood wainscoting. The furniture is all of rosewood with reddish-brown tufted-leather upholstering. The ceiling is of light oak, artistically paneled and capped; in the center of the room is a large skylight with handsome figured glass lights. The floor is of red and brown interlocking tile. Just abaft and between the engine casings are baths, lavatories, and a large barber shop. The plumbing throughout was furnished by Alfred B. Sands and Son.

Returning to the upper deck, aft of the boiler casing and forward of the engine casing are the officers' quarters. The officers' mess room is paneled in cherry and ash, with white ceiling, and English carpeting upholstery of neat design. The central station for the electric plant is also located here.

The first-class galley is on the main deck under the pantry. On this deck there is a central passage, about 3 feet 6 inches wide, extending from the second-class pantry on the starboard side of the engine hatch forward to the third-class pantry about under the first-class dining saloon. The galley is on the port side of the passage, and directly opposite on the starboard side is the galley for second and third classes and for officers.

The entrance to the second cabin is at the after end of the main house on the upper deck, between the engine hatches, where a stairway leads to the deck below. On the port side of the engine hatch is the smoking room, with ash side paneling and round air ports and walnut matched wainscoting. The floor is rubber tile and the upholstery of dark-brown pantasote.

The ladies' room is on the starboard side, and has side paneling of sycamore. The ceiling is white staff and the floor is hard wood, covered with rugs. The upholstery is again of dark-red pantasote.

The stairway from the upper deck leads to a small hall. On the starboard side, just aft of the pantry, and running the entire length of the space, is the dining saloon, seating 80 people. This room is finished with side paneling of oak, light finish, and oak furniture. The side lights are circular. The upholstery is of dark-green English carpeting, with lighter green draperies and curtains; the ceiling and beam capping are of white, paneled, and the floor of hard wood. On the port side of the engine casing are a few officers' rooms and be-

NAME—Minnesota. NATIONALITY—American TYPE—Ocean passenger and freight steamer.
LAUNCHED—1903. BUILDER—East. Shipbldg. Co. OWNER—Great Northern Steamship Co.

Length over all	630 ft.
" b. p.	608 "
Beam, molded	73 "
Depth at side, mid-length	56 "
" " " lowest point of sheer	54 " 6 ins.
" " center	57 " 6 "
Block coef.	.761
Prismatic coef.	.800
Midship sec. coef.	.951 ft.
Load draft	33 ft. 0 ins.
Load displacement	33,000 tons
Launching displacement, about	12,000 tons
Wetted surface	68,000 sq. ft.
Gross tonnage, about	21,000 tons
Net "	15,000 "
Propellers, No. of blades	3 each
Diameter	20 ft. 0 ins.
Pitch	22 " 6 "
Area, developed	98.7 sq. ft.
" projected	81.6 " "
Weight, each	37.5 tons
Material	cast steel, both hubs and blades

NAME—Minnesota. NATIONALITY—American. TYPE—Ocean passenger and freight steamer.
LAUNCHED—1903. BUILDER—R. S. Co. OWNER—Great Northern Steamship Co.

Engines, number	two
Type	triple 3-crank
Cylinder diams.	29, 51, 89 ins.
Stroke	57 "
I. H. P., estimated	10,000
R. P. M., "	78
Speed "	14 knots
Condens. surf. two main., 13,500 sq. ft.	
Valves....H. P. and I. P. piston, L. P. slide	
Boilers, number	16
Type	Niclausse Water Tube
Pressure	250 lbs.
G. S., total	1,080 sq. ft.
H. S., "	39,264 " "
Draft	induced
Height of stack above grates	124 ft. 10 ins.
Donkey Boiler	vert. tubular
Size	5 ft. diam. by 10 ft. 6 ins. high

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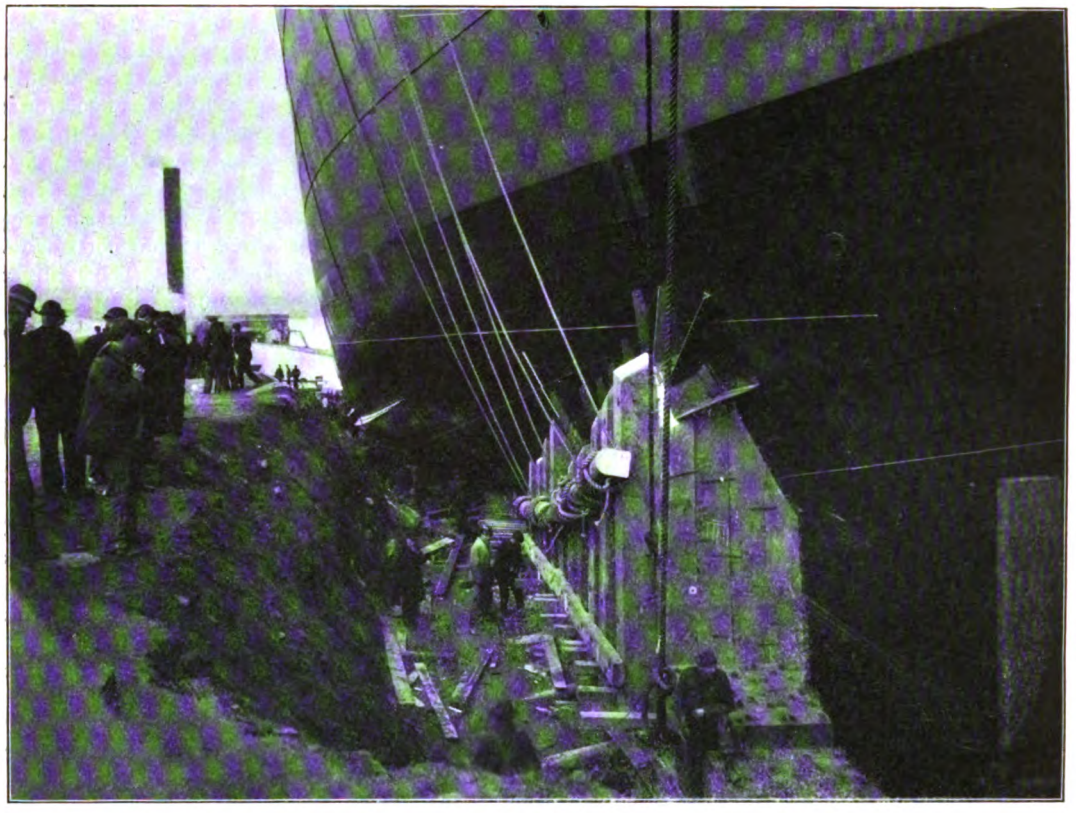

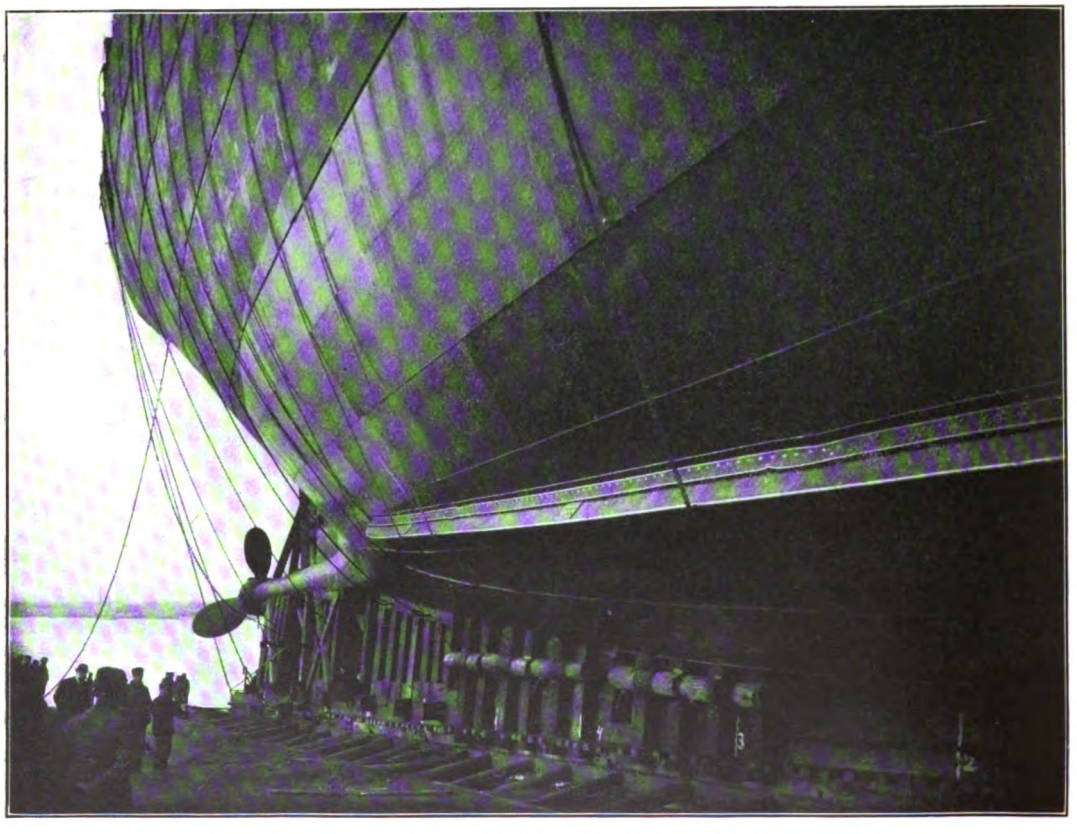

FORWARD AND AFTER POPPETS UNDER THE MINNESOTA, READY FOR LAUNCHING.

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tween the casing are baths and lavatories. The rest of the space is devoted to state rooms, each room having two berths, a good-sized seat, and a folding cabinet; the finishing is entirely in white.

In the small house just forward of the main house are the petty officers' quarters in the after end, the refrigerating-machinery room in the forward end, and the third-class entrance. A stairway leads to a passage on the main deck which opens into the third-cabin space, which is 48 feet long by the full width of the ship. In the forward end is the dining room, seating 68 people, and in the after end is the pantry, which opens to the passage leading to the galley. State rooms occupy the remainder of the space.

Still further forward is the crew's house, with entrance to crew's quarters on the main and forecastle decks. The house contains a galley for Asiatic crew, a blower, and store rooms.

In the steering-gear house at the after end of the vessel, besides the steering machinery, there is a galley for Asiatic steerage, quarters of laundrymen, blower room; and in the forward end is the laundry. Below, on the main deck, are toilets for steerage, and forward of this, running to the second cabin, is a large space arranged to be used for cargo, troops, or storage. The space forward of the third cabin is also for storage or troops.

GENERAL.

At the time of launching, the *Minnesota* weighed more than 12,000 tons, and the ways necessary for transporting this weight were enormously heavy. The pressure on the fore poppets at the pivoting point was so great that the ground ways below water were built wider, so as to decrease the pressure per square foot. The weight on the fore poppets is estimated at 1,200 tons each. The declivity of the ways is 5-8 inch in 1 foot; the width of each sliding way, 5 feet 4 inches; the inclination of the keel, 1-2 inch in 1 foot; the length of the ways below water from the sea wall is 210 feet.

The launching was delayed for about an hour and a half, owing to trouble in loosening up the blocks under the keel and bilges. When the men began to saw away the sliding ways, so great was the strain on the timber that it snapped in two. The ship started very gradually, giving plenty of time for the sponsor to christen her. She gathered more speed, and in 1 minute 7 seconds she slid the length of the ways; 55 seconds later the water closed around her bows and she began to settle free from her cradle. Her headway was checked three hundred yards out in the stream by lines from towboats near at hand, and then she cast her anchors and heaved to easily. One peculiar feature, which prevented our photographer from securing a view of the launch, was the smoke that enveloped the bows. The tallow was heated by the weight and friction to such an extent that a cloud of blue smoke arose.

The design of the *Minnesota* and her sister ship has been carefully worked out by President Hanscom and his assistants, and the construction and launching has been under his personal supervision. The *Minnesota* is now being fitted out at the company's wharf, and is expected to be ready for service in the course of the next few months.

THE INFLUENCE OF DEPTH OF WATER ON THE RESISTANCE OF SHIPS.

BY CHARLES P. PAULDING.

There are two important practical considerations under this heading—the limiting economical speed of vessels in shallow water, and the determination of the least permissible depth for the contract trial of a given vessel required to make a given speed. Several articles on the first of these questions have already appeared in MARINE ENGINEERING, but possibly the matter is important enough to warrant a little further notice, particularly as this happens to be incidental to a study of the second question.

The data on which these notes are based may be found in a paper read in 1900 before the Institution of Naval Architects by Captain Giuseppe Rota, of the Italian navy; in a paper presented to the same society in 1899 by Captain Rasmüssen, of the Danish navy; and, finally, in a paper read before the International Marine Congress at Düsseldorf in 1902, by Mr. J. Schütte, the engineer in charge of the North German Lloyd Company's model tank. Captain Rota and Mr. Schütte experimented with models about 12 feet in length, in well-equipped model tanks; Captain Rasmüssen, on the other hand, made his experiments with a torpedo boat of 132 tons displacement.

The curves of the original papers have been redrawn to a large scale of English units before reproduction here.

Fig. 1 gives the resistance curves of a torpedo-boat model, and near each curve is a figure showing the depth of water in feet in the tank during the determination of that particular curve. Attention is called to the pronounced humps in the curves and to the relative position on these humps of the short vertical lines marking the limited speed of a wave of translation in that particular depth of water. As explained in Mr. Stevens' article, this speed is determined by the formula $v = \sqrt{gh}$, where v is the speed in feet per second and h the depth in feet. Above this point the usual wave system is unable to keep pace with the boat and the wave-making resistance is consequently very much diminished. This abnormal increase of resistance takes place at the same speed, regardless of the size of the vessel, although its amount varies greatly with different vessels or with the same vessel at different displacements. All this was fully brought out in the previous articles, but what should be emphasized here is that the wave speed is considerably above the economical limit, in fact for any but torpedo boats it is above the possible speed of a vessel, and if any regard is to be had to economy we must be content with a speed nearly, if not quite, two knots less. A study of Figs. 1, 2, and 4 will make this sufficiently obvious.

In Fig. 2 the dotted curves represent Captain Rasmüssen's experiments, while the full line curves show the approximate horse power, for a torpedo boat, derived from the model curves of Fig. 1. It is to be noted that, while the boats are of the same length, their displacements differ greatly, and it naturally follows that the powers are quite different. The wave speed corresponding to the depth is marked on each curve as in Fig. 1. Only one curve for the *Söbjörnen* is of such shape as to conspicuously show the relative position of

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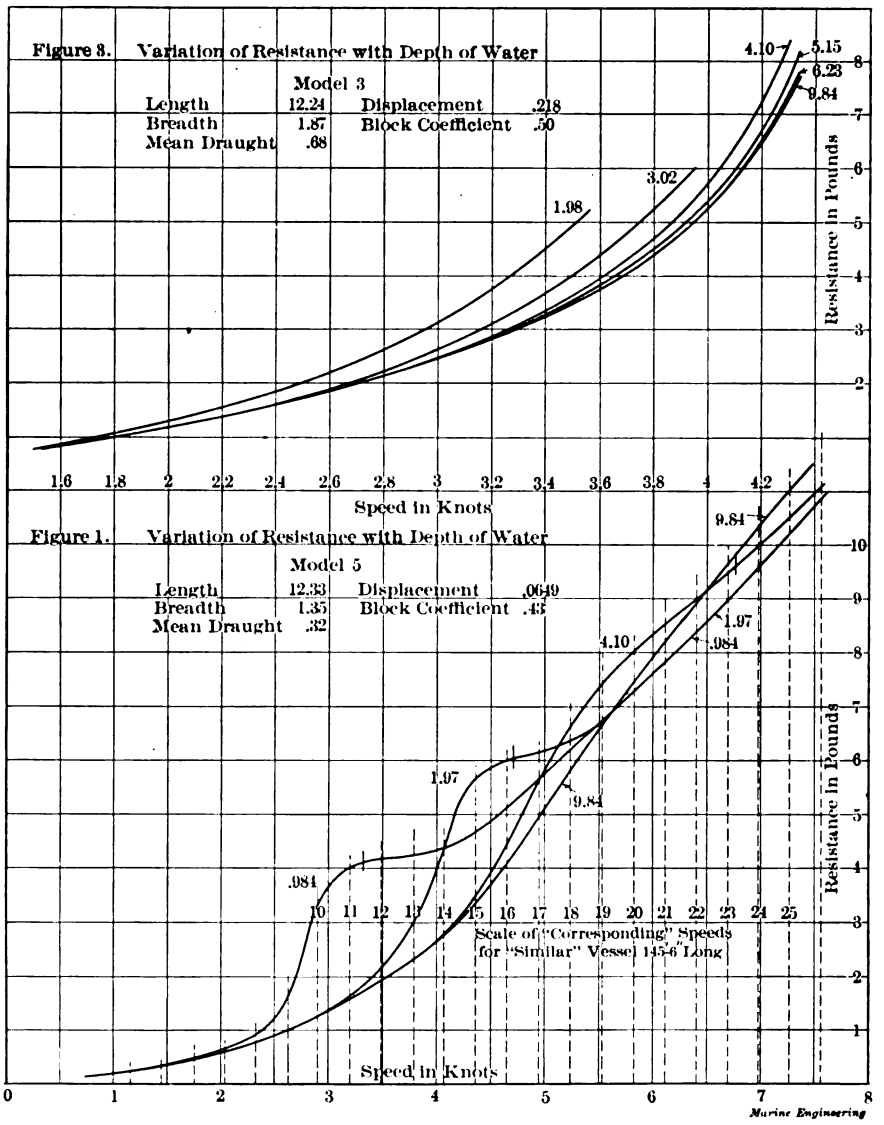
this wave speed; it may be taken as thoroughly characteristic, since a number of other experiments by this same officer show the same thing. Now, the curves for the derived vessel show the same position of the wave-speed mark relative to the hump in the resistance, and are precisely what we would expect from the *Söbjörnen* if she had been run at these depths, except that the increase of resistance is much smaller. Rasmüssen showed that the power necessary at this point was greatly influenced by even a small change of displacement, and we have here a very large change and different proportions besides. The qualitative resemblance is the important one in our comparison, not the quantitative one, and we are evidently able to make very useful predictions in regard to a ship in usual depths of water from the tank experiments with a 12-foot model.

Perhaps an apology is due, in this age of model tank experiments, for supposing that anything else could be the case; but although it is an integral part of Froude's theory that for vessels of the same model, at corresponding speeds, the depth of water affected by their motion is directly proportional to their linear dimensions, it is not a point which has been much dwelt upon.

Before proceeding to the second part of the subject, the least depth of water at which a vessel may be run without perceptible increase of resistance, it will be well to briefly consider the method of estimating the resistance of a ship from the results obtained by towing a model in an experimental tank, taking for an example the derivation of the full line curves of Fig. 2 from those of Fig. 1. The length of the model is 12.33 feet; the length of the derived vessel is determined here by the necessity, for the purpose in hand, of having it the same as that of the *Söbjörnen*, namely, 145.5 feet. The scale of ship to model is therefore 145.5 ÷ 12.33, or 11.8. All linear dimensions of the ship are found, then, by multiplying the corresponding dimensions of the model by 11.8, the wetted surface by multiplying by the square



FIGS. 1 AND 3.

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of 11.8, and the displacement by multiplying by the cube of 11.8. Now, Froude showed, by mathematics and experiment, that when a ship and its model are driven at speeds connected by the ratio $\frac{\sqrt{\text{length of ship}}}{\sqrt{\text{length of model}}}$ the wave-making resistances are in the ratio

$$\frac{\text{displacement of ship}}{\text{displacement of model}},$$

or, in other words, for speeds in the ratio of the square root of the scale of ship to model the wave resistances are in the ratio of the cube of the scale. The frictional resistance follows no such law and must be computed separately for ship and model. In Fig. 1 we have the curves of total resistance for the model, and to determine the wave-making resistance—and it must be remembered that it is this resistance that introduces so much uncertainty in our estimates of the resistance of ships—we must calculate by means of Froude's tables the frictional resistance. From Taylor's *Resistance of Ships* we find the formula with the numerical coefficients appropriate to this length of model in fresh water to be;

Resistance in pounds

$$= f \times \text{wetted surface} \times (\text{speed in knots})^n$$
$$= .009 \times 15.95 \times (\text{speed in knots})^{1.94}$$

In this case we had to estimate the wetted surface of the model, but for our purpose the error thus introduced, though possibly quite large, is immaterial. By the above formula we draw on Fig. 1 a curve of frictional resistance (not shown). At four knots, for example, this amounts to 2.11 pounds. At any speed the vertical distance between this curve and the curve of total resistance represents the wave-making resistance, but in extending these wave-making resistances from model to ship we must remember that they are only connected at corresponding speeds. Thus a speed of four knots for the model corresponds to $4 \times \sqrt{11.8} = 13.73$ knots for the derived vessel, and to simplify this part of the work we lay down on Fig. 1 a scale of corresponding speeds for the derived, or "similar," ship. It only remains to com-

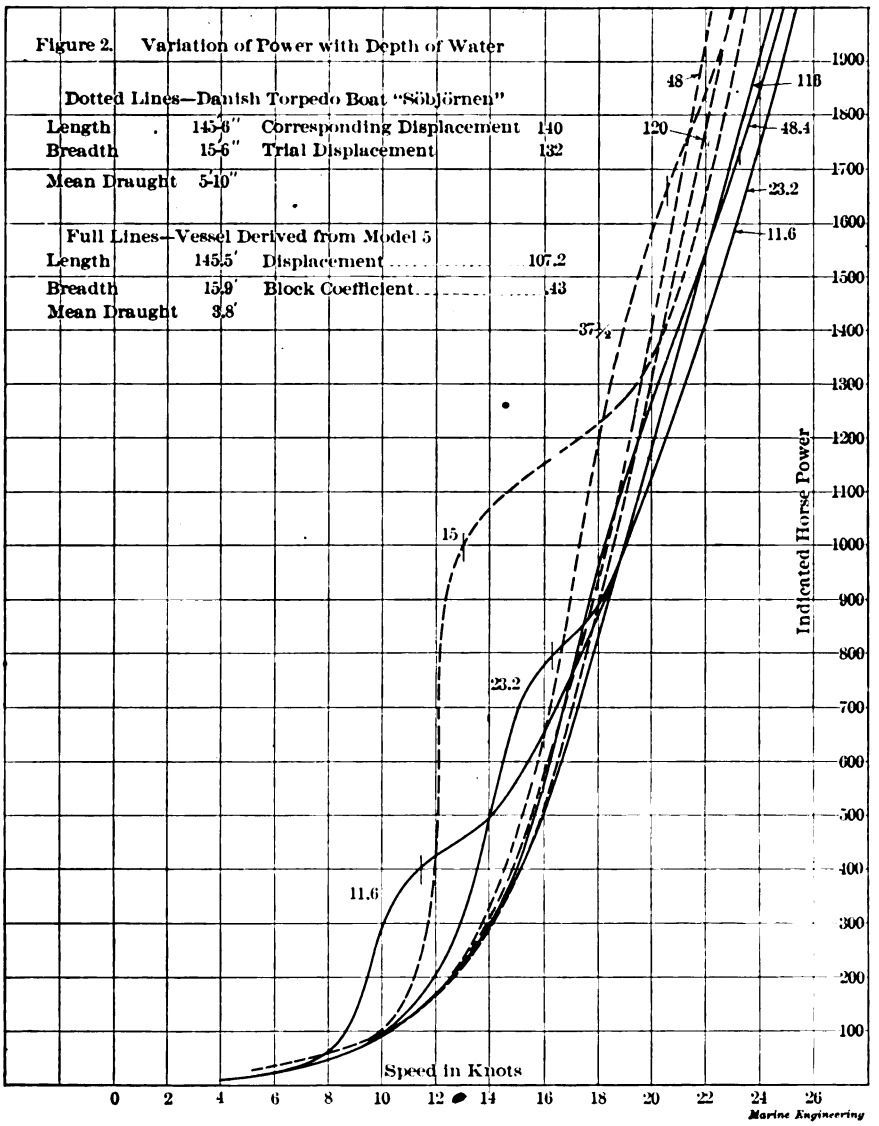

FIG. 2.

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pute the frictional resistance of the ship. Referring again to the tables in Taylor's *Resistance of Ships*, we get for a clean steel vessel of this length in salt water:

Resistance in pounds

$= .0096 \times 2220 \times (\text{speed in knots})^{1.83}$

Take, for example, the ship at 13.73 knots, corresponding to four knots for the model; the frictional resistance of the model we have already found to be 2.11 pounds; the total resistance at four knots for the curve obtained in .984 foot of water we see on Fig. 1 to be 4.32 pounds; then the wave-making resistance is $4.32 - 2.11 = 2.21$ pounds, and the wave-making resistance of the ship at 13.73 knots will be $2.21 \times 11.8^3 = 3{,}632$ pounds. The frictional resistance of the ship we find from our formula to be 2,573 pounds; then the total resistance is $3{,}632 + 2{,}573 = 6{,}205$ pounds, at 13.73 knots. The corresponding horse power is $6{,}205 \times 13.73 \times .00307 = 262$, and assuming a propulsive coefficient of .55 we have 477 indicated horse power.

The figures for depth of water near the full line curves of Fig. 2 are obtained from the corresponding figures in Fig. 1 by multiplying by 11.8, because it is a fundamental part of Froude's theory that the stream lines around similar vessels are similar and differ only in scale; therefore the effect of the bottom when one foot below our model would be the same as the effect of the bottom 11.8 feet below the ship.

We are now in a position to draw some useful conclusions from the model tank experiments; turning to Fig. 3, we have the resistance curves at different depths of a model of the dimensions given on the figure. Suppose that we wish to know the least depth in which a cruiser of the *Denver* class, now nearing completion for the navy, can be driven at the contract speed of 16.5 knots without "feeling the bottom." The cruiser's dimensions and those of a vessel of the same length derived from the model are as follows:

	Denver	Vessel derived from Model 3.
Water-line length	292 ft. 0 in.	292 ft.
Breadth	43 " 3¼ "	44.5 "
Draft	15 " 9 "	16.25 "
Displacement—tons ...	3,200	3,000

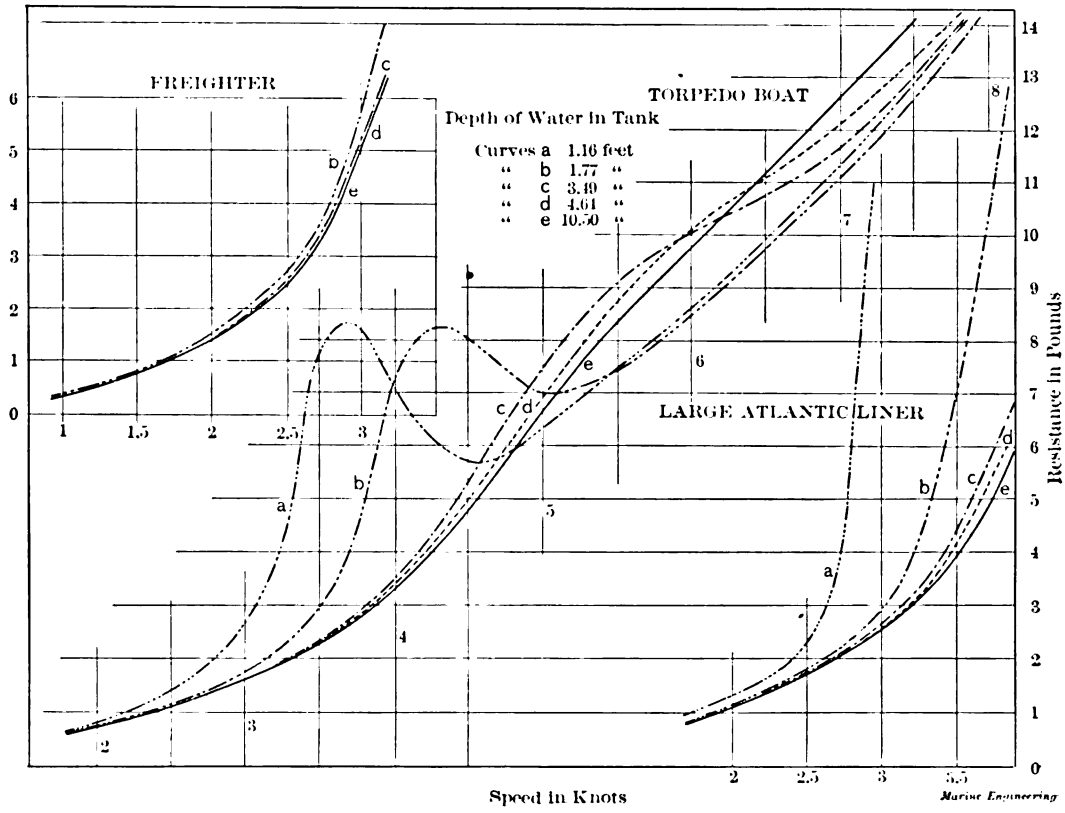

FIG. 4.

The agreement is sufficiently close for our purpose. Since the scale of ship to model is 23.9, the model speed corresponding to the *Denver's* 16.5 knots is $16.5 \div \sqrt{23.9} = 3.38$. Referring to Fig. 3 we see that 6 feet is about the smallest depth for that speed consistent with no increase of resistance. The corresponding depth for the *Denver* would be 6×23.9, or say 150 feet. A similar calculation for the *St. Louis* class, length 424 feet, contract speed 22 knots, gives a depth of 200 feet; and for the *Tennessee* class, length 502 feet, contract speed 22 knots, the depth works out at 230 feet.

At a depth of 95 feet the *Denver* would, at 16.5 knots, experience an increase of resistance of about three per cent., at 72 feet an increase of about twelve per cent.

The steam yacht *Niagara* has a water-line length of 248 feet; if she were able to steam at 17 knots she would require a depth of 125 feet. The *Dreamer*, 149 feet long,

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would require 120 feet at 15 knots. It seems strange that the smaller vessel at lower speed should require practically the same depth of water, but it must be remembered that the increase of resistance is entirely an increase of wave-making resistance, and that a 149-foot boat at 15 knots is experiencing much greater proportionate wave-making resistance than a 248-foot boat at 17 knots. The 502-foot *Tennessee* could steam 15 knots in this same depth without feeling the bottom.

The curves of Fig. 3 are suitable for cruisers, for yachts, and for finely-modeled passenger steamers of moderate size. From experiments (Rota's) with a model resembling fairly closely a battleship of the *Georgia* class, it would appear that the depth obtained from Fig. 3 needs, at 19 knots, to be increased about ten per cent., giving a corrected depth of 200 feet.

Turning now to Fig. 4, which represents Schütte's experiments, we find the resistance curves from the models of a very large Atlantic liner, a large freighter, and a torpedo boat. The principal dimensions of the models are given in the following table:

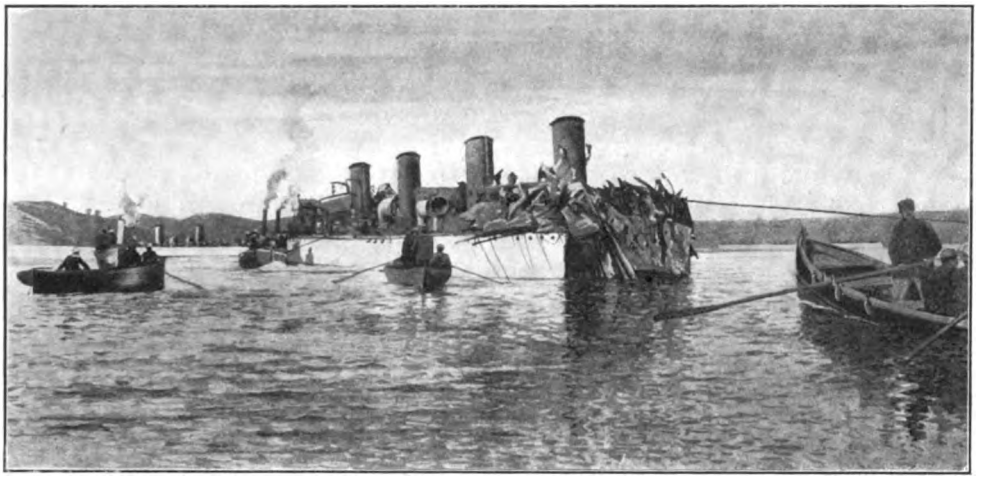
	Freighter	Tpdo. boat	Liner
Scale of ship to model.....	40	17.5	45
Length in feet.....	13.07	11.42	14.12
Breadth in feet.....	1.500	1.292	1.464
Draft in feet.....	.645	.346	.582
Displacement in tons.....	.2612	.0643	.2052
Wetted surface in sq. ft.....	29.85	14.09	26.35

The model of the liner was made to represent a ship 635 feet long and of about 19,600 tons displacement; at a speed of 23 knots the corresponding model speed would be 3.4 knots, and from the figure we may say that at least 6 feet of water are required, and for the ship this becomes $6 \times 45 = 270$ feet. It is interesting to note that curve *a* represents roughly the conditions of resistance for this vessel steaming from the bar to Quarantine. Under these circumstances her full power would barely drive her at 18 knots. The wave formation along the sides of one of these great vessels, in the shallow water of the lower bay, when it is making every effort to reach Quarantine before sunset, is a sight not to be forgotten.

The model of a freighter represents a ship 523 feet long and of nearly 17,000 tons displacement; at 14 knots the model speed would be 2.2 knots and curve *c* would give the requisite depth, namely, $3.49 \times 40 = 140$ feet.

These very considerable depths of water for minimum resistance are confirmed by the practice of the navy, where all vessels of any size are taken well out to sea for their acceptance trials.

Mr. Schütte also experimented with a deep but narrow channel of variable width, and the results showed that the torpedo boat needed a width of channel of about fifteen times her own breadth, the liner about twelve times, and the freighter six times. With narrower channels the resistance was seriously increased, although the increase was neither so rapid nor so great as with shoaling of the water. The curves for the torpedo boat at very high speeds fell below the normal curve very much as they did in shallow water.



THE WRECKED BRITISH TORPEDO-BOAT DESTROYER ORWELL.

Wrecked Torpedo Boat.

The cut herewith presented, and reproduced from the *Illustrated London News,* shows the British torpedo-boat destroyer *Orwell* after colliding with *H. M. S. Pioneer* on the night of January 30. The accident occurred during night manœuvers in Corfu channel, when the destroyer was steaming at about 15 knots to a rendezvous outside the area of operations to await further instructions. The *Pioneer,* showing no lights whatever, suddenly approached, and, before anything could be done to avert a collision, she had crashed through the port side of the *Orwell,* cutting through at an angle of about 30 degrees and completely severing over 40 feet of her bows. Two officers and thirteen petty officers and seamen were killed and drowned by the collision. The engine-room department sustained no loss, and it is stated the engines are not injured. The vessel was towed to her moorings and berthed alongside the cruiser *Trine.*

The *Orwell* is a 30-knot destroyer, built in 1898 by Laird Bros., and is fitted with Normand boilers. She carries a crew of sixty men.

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AN OLD WRECK BURIED IN THE SHIFTING SANDS OF CAPE COD.
[Photograph by T. E Marr, Boston, Mass.]

WRECKING WORK OF THE BOSTON TOWBOAT COMPANY.

BY WINTHROP L. MARVIN.

There may be coasts as dangerous as that which stretches in alternating rock and sand from Nova Scotia to Long Island sound, but there are few whose waters bear such a heavy commerce, conducted in fair weather or foul, in snow or rain or fog or sunshine, the whole year around. It is not strange that with so great a traffic on so hazardous a road there should be occasional disasters; this is the inevitable price of navigation. But, though the risk is large all along this bold seafront of New England, the means of saving life and property are proportionate. The national government has elaborately lighted and buoyed this northern coastline, and private enterprise provides abundant facilities for the prompt rescue of valuable ships that go ashore.

With headquarters at the chief New England port, in the very center of this long seaboard, the Boston Towboat Company, of which Mr. Alfred Winsor is president, Capt. William F. Humphrey treasurer, and Mr. Thomas I. Winsor manager, watches every mile of the coast through its agents in every ocean village. South of Cape Cod, in the convenient harbor of Vineyard Haven, the company maintains a separate station, with a wreckmaster and diver, a large lighter, six steam pumps and boilers and other paraphernalia, and through the winter months a powerful tug, for the relief of a distressed vessel or cargo anywhere along the range of Vineyard and Nantucket sounds.

At the head of its wrecking fleet the Boston Towboat Company possesses a large ocean-going steamer, the *Orion*, with one-third more steam power than is usual in vessels of its class, and equipped with a patent towing apparatus—a reel controlled by steam cylinders. This apparatus is employed to pull off unfortunate vessels that have grounded. A wire cable and a manila cable are used together, so arranged that the first strain comes on the relatively elastic manila. When this is stretched nearly up to the limit of its tension, the steel cable in turn "takes hold," and it must be a very firmly rooted craft indeed which will not come off under this formidable persuasion. To prevent still further the wasteful breaking of cables, the reel is so adjusted that when a certain strain is reached the apparatus automatically unwinds.

Next in importance in the company's wrecking fleet comes the big, full-powered wrecking tug *Underwriter*, originally built by the marine underwriters of Boston to protect their interests on the New England coast, and afterward purchased by the towboat company. She is maintained constantly in first-class order, ready for any call, and has saved many a good ship and cargo from destruction. Besides the *Underwriter* there are two other large wrecking tugs, the *Storm King* and *Mercury*, and 18 other tugs for bay or harbor service, with 23 lighters of all kinds, including three distinctively wrecking lighters, the *Aid, Oak,* and *Salvor*. The wrecking apparatus includes 16 modern centrifugal pumps, pontoons, anchors, cables, blocks, chains, etc., all of which must be kept prepared for any emergency. The company employs three experienced wrecking divers.

Not only does the Boston Towboat Company successfully conduct the coast wrecking business of New England, but many of its achievements have taken place far from home. When in March, 1894, the historic sloop-of-war *Kearsarge* crashed to her inglorious doom on the merciless reef of Roncador in the Caribbean, it was this Boston company which was chosen by the government to fit out the expedition of rescue—and it is no fault of the company that the plan did not succeed. The *Orion*, with a strong crew and ample apparatus, was promptly sent southward, but before she could complete her long voyage the *Kearsarge* had been robbed and burned by Caribbean pirates, who flocked to the spot like a

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A CREW OF BRAVE LIFE SAVERS; THE SURFMEN OF ONE OF THE CAPE COD STATIONS.
[Photograph by T. E. Marr Boston, Mass.]

crowd of vultures at the first news of the disaster. The *Orion* had to content herself with bringing home some parts of the equipment and a few relics of the gallant conqueror of the *Alabama.*

Once again, in June, 1897, the *Orion* steamed far down the southern seas to rescue the British tramp *Ethelgonda,* from Argentina for Boston, which had gone ashore on St. Lucia with a cargo of wool valued at several hundred thousand dollars. The unlucky ship lay on the windward side of the island, in an exposed position, right in the midst of a furious surf. She had settled so far that half of her cargo was submerged, but the other half of the wool was dry. The *Orion* anchored about a mile away from the *Ethelgonda,* in safe water, and brought the dry wool off in native pirogues whenever the weather permitted. In this way half of the cargo was saved, and then the *Orion,* with full holds, returned to Boston. As soon as she left the wreck her sister ship, the *Saturn*—sold a year later to the Navy Department as a collier in the Spanish War—was dispatched to the *Ethelgonda.* Steam pumps were put aboard the helpless vessel and the holds were freed of water. Then the powerful *Saturn*—equipped, like the *Orion,* with a patent towing apparatus—succeeded by "jumping" in hauling the *Ethelgonda* off the reef, and brought her into the shelter of Port Castries. There the wet wool was unloaded and dried. These Yankee wreckers were not, however, yet through with their undertaking. They took the floated ship over to Martinique, put her into dry-dock, made temporary repairs, and then crossed the ocean and delivered her safe in Liverpool. This extraordinary wrecking task, begun in June, was not completed until October.

Still again, the *Orion* went down to Barranquila, near Colon, on the Isthmus of Panama, to the stranded Norwegian steamer *Fri,* pulled her off, and towed her to New York. In February, 1898, it was once more the Boston Towboat Company which was selected by the government to go to the rescue of a national ship. An expedition was sent out from Boston to the shattered *Maine* lying in Havana harbor. But the battleship—the tomb of 266 brave men—was of course found to be a hopeless wreck and not worth raising. In October, 1902, this company was called to Havana on a very different mission—to tow from there to our navy yard at Pensacola the Spanish floating dry-dock which had passed into the possession of our government.

One especially difficult task of wrecking was that attempted when the Belgian steamer *De Ruyter* was driven ashore on the dreaded ledges of Scituate in March, 1890. The Boston Towboat Company sent down some of its most powerful apparatus, and managed to get the heavy ship afloat, but the steam pumps could scarcely keep the broken hull free, and the *De Ruyter* came very near foundering before she was dragged into Boston harbor.

Another and a still more difficult exploit was the saving of the Cunard steamer *Pavonia,* on the same perilous coast, in November, 1896. Inward bound in misty weather, the *Pavonia* sighted a rocky headland which her captain took to be Nahant. Accordingly he shaped his course southward to reach Boston light. Although he was warned by passing boats of his peril, this Briton, with true insular conceit, kept on his blundering course through the fog until he suddenly brought up "all standing" against the reefs and bars off Marshfield. Of course, the *Pavonia* was badly wrecked and torn, but the wreckers, coming promptly to the rescue, managed to drag her off the rocky bottom and to bring her up off Boston light, where the ship was anchored in the darkness and a heavy sea and wind, the pumps desperately working to keep down the inrushing water. But, as it was feared that the ship would sink with her passengers, who were still on board, she was brought, by skillful and daring navigation, inside the Nantasket roads, where her forefoot settled on a soft and friendly bottom and she and her people were safe.

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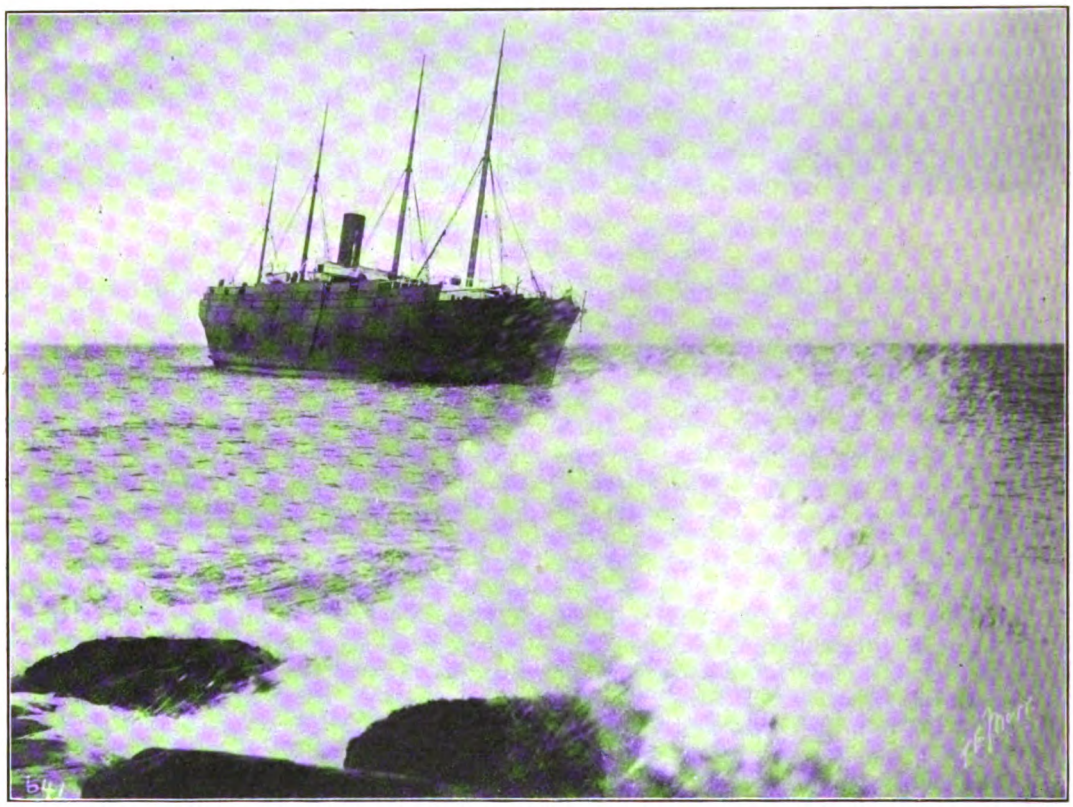
When the Leyland liner *Venetian,* outward bound for Europe, struck State ledge and sank in Boston harbor in March, 1895, the Boston Towboat Company took all the cattle off in five hours, before the tide could return and drown them. As for the old ship, she was slowly broken up for junk. Very much more fortunate was the Warren liner Norseman, inward bound from Liverpool, which lost her reckoning and suddenly drove up hard and fast on the jagged ledges of Marblehead neck in March, 1899. This was an exposed locality, and the ship was seriously damaged, but in twenty days of strenuous labor the Boston wrecking fleet succeeded in getting the *Norseman* once more into her proper element. First the cargo was lightered. Then a big hole in the bow was patched, and the water in the hull was reduced by pumps until the tugs managed to pull the great ship off the rocks and into Marblehead harbor. There a diver patched up, as is well illustrated in the accompanying engravings, the mutilated bottom, which could not be reached so long as the *Norseman* rested on her rough bed of boulders and ledges. Then the Warren liner was ready for bringing to Boston.

This is the customary process in the wrecking operations of the Boston Towboat Company: Just as soon as a wrecked ship is floated she is hurried into the nearest harbor for temporary repairs. If there is a drydock there, well and good; if there is none, resort is had to the slower and less complete but useful methods of the divers. If the ship now floats with about eight feet of water beneath her keel, the bold men in the diving suits can get at the injured bottom quite handily and stop the worst leaks. Sometimes these can be reached and remedied from the interior.

The great November gale of 1898, in which the sidewheeler *Portland* went down with all on board, wrought several wrecks within the sheltered area of Boston harbor. The big Reading tug *Tamaqua,* drawing 15 feet of water, was driven away up on Rainsford island. Next day, when the storm tide subsided to the normal, only five feet of water were left around the unlucky tug. It was obvious that no ordinary wrecking methods would meet this difficulty, so a dredging machine was resorted to, to dig out the *Tamaqua,* and also dredge a channel over two miles long to free the lake steamer *John J. Hill,* which had been forced by the same terrific storm away up on the shallow shore of Wollaston.



THE BRITISH SHIP NORSEMAN ON THE ROCKS OFF MARBLEHEAD, MASS.
[Photograph by T. E. Marr, Boston, Mass.]

In recent years the Boston Towboat Company's wrecking outfit has released the Savannah liner *Gate City* and the Clyde line steamship *Cherokee* from the too close embrace of Naushon, dragged the badly injured United Fruit steamer *Admiral Dewey* off the savage ledges of Cuttyhunk, raised the harbor steamer *Mayflower,* sunk in collision, pulled the Boston-Philadelphia liner *Spartan* off the Jersey beach, and floated the Plant steamer *Halifax* from an uneasy bed under the ramparts of Fort Warren. This same energetic company has lifted from the bottom two heavy sunken coal barges, the *Atlas* and the *Felix.* When the sloop-of-war *Galena* and the tug *Nina,* bound for Portsmouth, went

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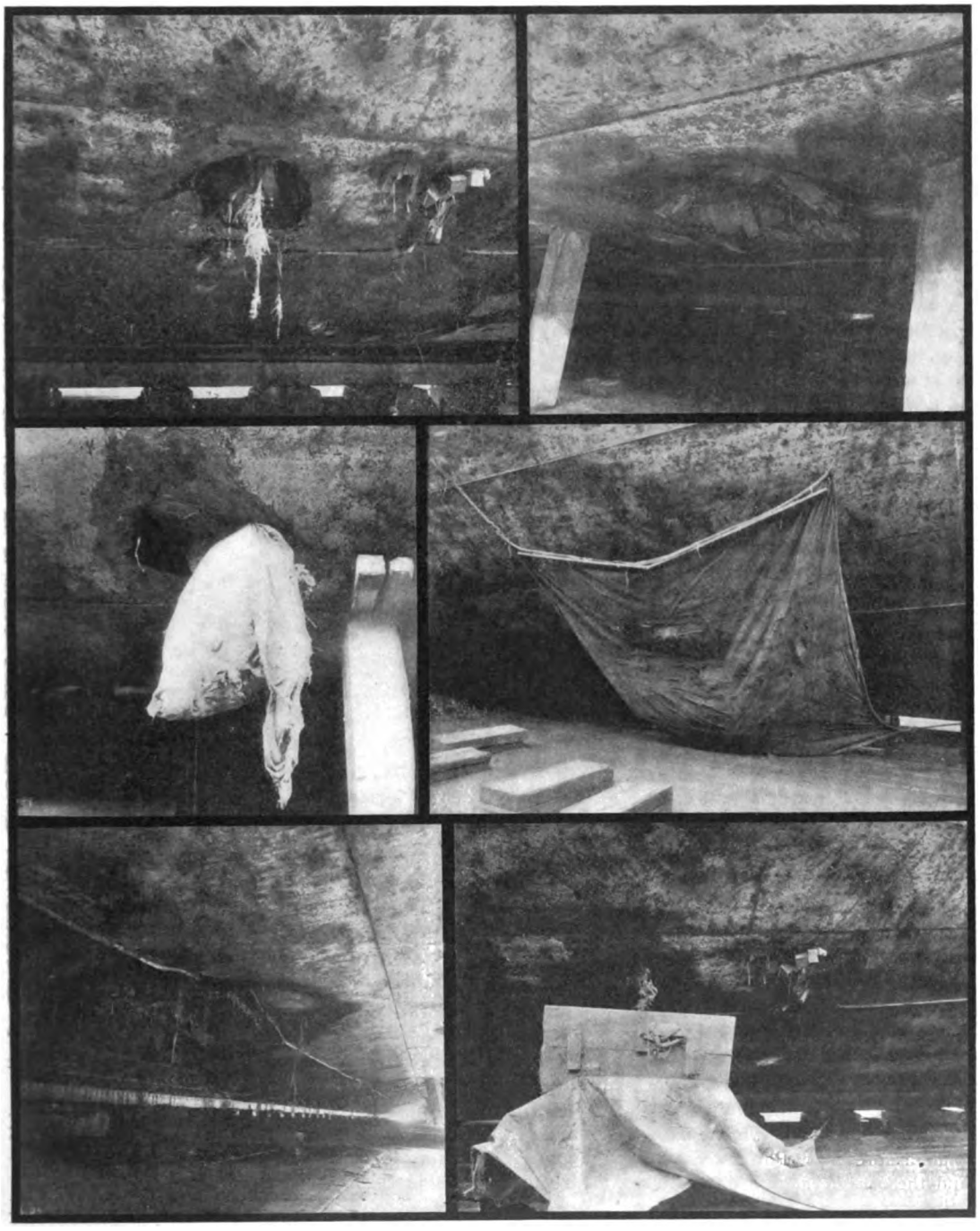
ashore together on Gay Head, it was the Boston wreckers who restored these ancient craft to the national service, and boats and men of the same company saved the sailing ship *Gov. Robie*, the barks *Albertina* and *Western Belle*, and the schooner *Andrew Adams*. One notable piece of far-away work was done when the steamship *Britannia*, wrecked on the Nova Scotia coast, was rescued and conveyed to Halifax and thence to Boston. And all this is an enumeration of only a few of the cases in which the company has come out victorious in its constant battles with the ocean.

The Metropolitan steamer *Henry M. Whitney*, outward bound, was struck a terrific blow in Boston harbor in September, 1892, by the incoming Liverpool liner *Ottoman*. A hole large enough for a tally-ho coach to drive through was torn in the *Whitney's* steel side, and



HOLES IN THE BOTTOM OF THE NORSEMAN, SHOWING TEMPORARY REPAIRS MADE BY DIVERS WHICH ENABLED THE SHIP TO BE BROUGHT INTO PORT.

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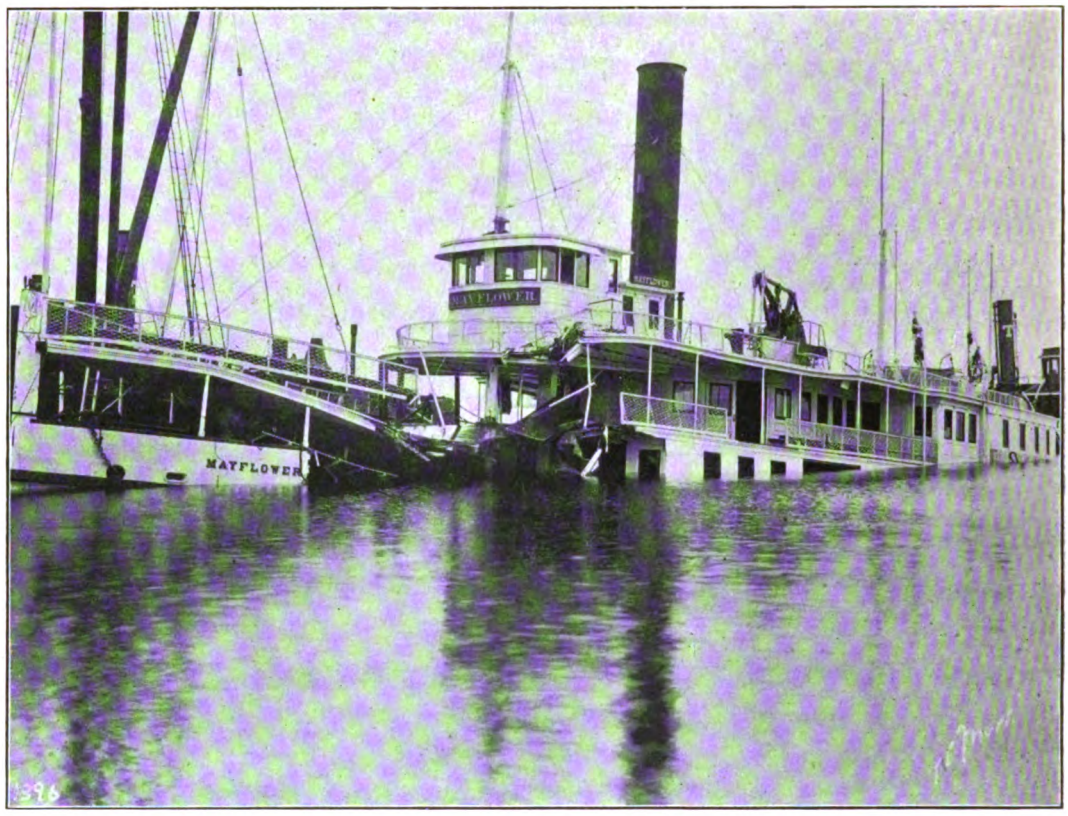
the wounded ship sank on the instant. Divers were sent down and stopped the huge leak, patched the decks, and lifted the *Whitney* out of the depths of the busy channel to the East Boston repair dock.

When the lighthouse supply steamer *Armeria* went ashore in Penobscot bay in the summer of 1897, she drove at high tide on a lone or pinnacle rock abaft of amidships. Now the tide rises and falls a dozen feet or more in Penobscot bay, so when it went out it left the vessel suspended, as it were, on a pivot, with her bow deep down in the brine and her stern, rudder, and propeller far out of the water. The weather was fair and the *Armeria* had a good, strong American steel hull, so she hung together until the towboat company brought down its pontoons from Boston. They were skillfully attached to the ship at low water, and when the Penobscot tide came in it lifted the handsome ship off uninjured.

Still later rescues are those of the Allan liner *California,* ashore near Portland harbor in February, 1900, and the *Massapequa,* only a few months ago, on the south shore of Massachusetts. Another noteworthy exploit carried out by this company and described in these pages in the April and July, 1902, issues, was the saving of the British steamer *Wilster.* This almost new and valuable vessel, with a rich cargo of 3,000 tons of bag sugar, struck among the boulders of Pebble beach, Rockport, Cape Ann, February 28, 1902. Five successive gales of wind drove the wrecking craft away from their work, but they kept on undaunted, until, after a month of labor, they got the *Wilster* afloat on March 27 and saved half of her cargo. The bottom of the ship was fairly corrugated by so many days of rolling and pounding on Cape Ann rocks, and the requisite repairs made the *Wilster* so much of a Yankee ship that she was admitted to our registry and now flies the Stars and Stripes above the good Yankee name of *Dorothy.*

An achievement of which the Boston Towboat Company is even prouder, and justifiably so, is the saving of the fine Boston-Philadelphia liner *Indian* from the reefs near Cuttyhunk, known as the Sow and Pigs, reputed to be the graveyard of every ship that ever struck there. This case of salving was also illustrated and described in MARINE ENGINEERING, August, 1902. The *Indian's* bottom plating was badly smashed and her lower hold filled with water, when the ingenious expedient was resorted to of floating the ship off on her lower deck. The hatches were heavily planked over, calked, and shored, and the deck itself was shored down to resist the terrific pressure. Fifteen centrifugal pumps were set to work, and the ship was finally lifted off the ledges and towed into Vineyard Haven. It is said of the Cuttyhunkers, who have lived for years off the spoil of wrecks, that they declared among themselves that they would quit their island if the *Indian* was saved! A year or two before the Merchants' and Miners' steamship *Fairfax* had gone ashore nearby, and her bones are rusting among the ledges.

As to the *Massapequa,* she went ashore at Marshfield last February at high water. Before another high water



THE STEAMBOAT MAYFLOWER, SUNK BY COLLISION.
[Photograph by T. E. Marr, Boston, Mass.]

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the towboat company's tugs had fastened to the vessel, and at the flood they pulled her off. Within five hours thereafter a heavy gale came on, which would have proved sure destruction to the vessel if she had remained.

The centrifugal wrecking pumps, of which the company has sixteen, are in general of the 8-inch type, which have been found to be as large as it is convenient to handle. These pumps are driven by steam at a pressure of about a hundred pounds, and they have a capacity for from 2,500 to 3,000 gallons of water a minute. On the *Indian* fifteen of these pumps were in operation at one time. One of the steam boilers which the lighters carry can work two pumps, if fresh water is available. But one boiler is required to run one pump if, as often happens, the only water to be had is the briny liquid right from the ocean alongside. Each of the wrecking lighters of the Boston Towboat Company carries two boilers and four pumps, and there are half a dozen pumps always in reserve at the company's station in East Boston. The portable boilers by which these pumps are operated weigh about four tons each. Under certain conditions steam is sometimes supplied to the pumps through hose from tugs lying alongside the wrecked vessel. The derricks of the wrecking lighters can lift about fifteen tons, but the heavy lighter *Bull* is capable of handling fifty tons.

Such an ocean wrecking business as that carried on by this company demands fine sailor-like skill and manly hardihood. It is a trade of large risks and heavy expenditures. The mechanical and engineering problems are often sudden, unforeseen, and bewildering except to men of dauntless pluck and long experience. Up to twenty-five years ago the extraordinary hazards of the calling were frankly recognized, and a wrecking company was employed by the day and paid whether or not it was successful. But the underwriters finally objected to this practice and insisted on the principle of "no cure, no pay." For twenty years or more, therefore, the reward of a wrecking operation has been contingent on success. The saving of the *Indian* last year, for instance, required sixty days. If on the fiftieth day a gale had come along, it might have meant the instant, absolute waste of all the time and money that had been spent by the company upon preparing to float the ship, or fully $60,000.

DREDGING OUT THE JOHN J. HILL, BLOWN ASHORE IN A HURRICANE.
[Photograph by T E. Marr, Boston, Mass.]

Sometimes the wrecking company may strike what seems to be a bit of easy good fortune—as when in March the *Underwriter* and *Storm King*, dispatched from Vineyard Haven to the British steamer *Parkgate*, ashore on Nantucket shoals fifteen miles east southeast from Sankaty head, found the steamer already afloat when they reached her, and had only to pilot her out of the labyrinth of sandbars. But it ought to be remembered that in the thick, rough weather prevailing it was difficult and hazardous for the tugs to venture among these shoals, shifting with every storm and out of the usual paths of navigation, and, moreover, that the company is constantly maintaining at Vineyard Haven at heavy cost these resources of so much benefit to

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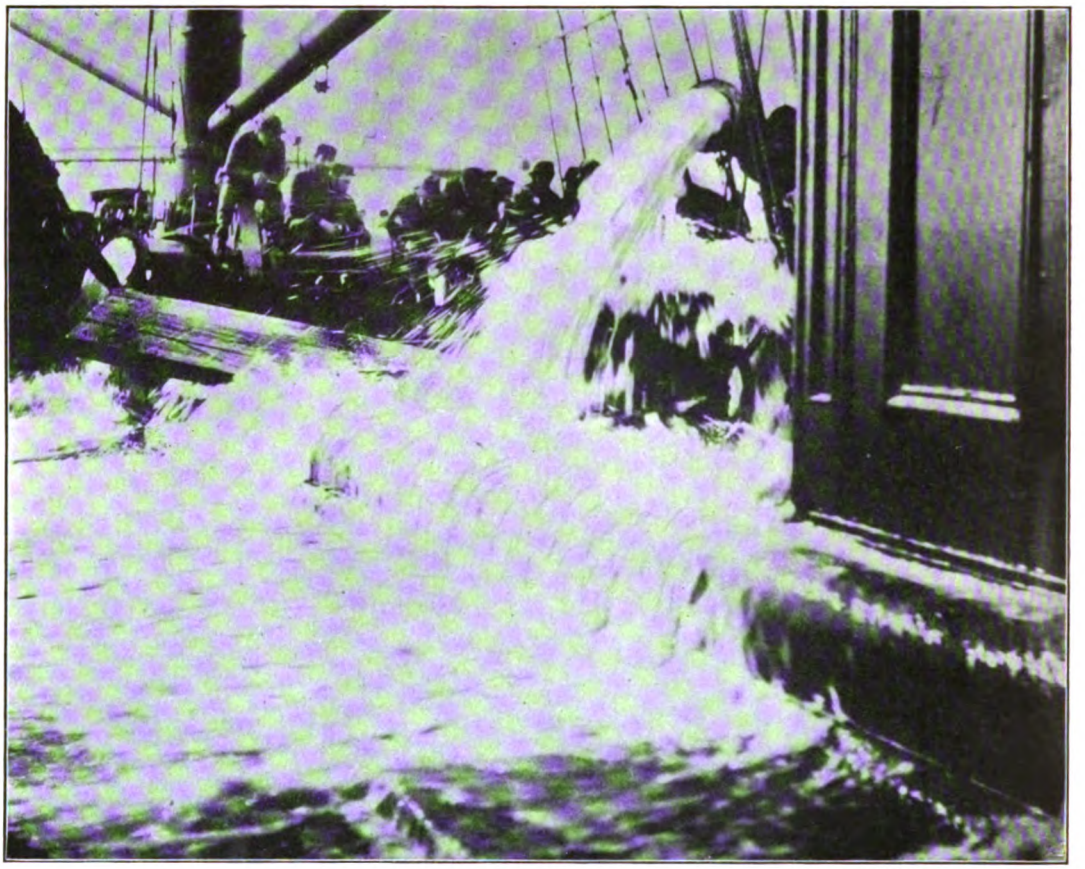
commerce and humanity. The *Parkgate,* though afloat and anchored, lay in the midst of dangerous shoals from which she could not have escaped without assistance. But for the guidance of the two tugs, that were in frequent peril themselves, the *Parkgate* would unquestionably have shared the fate of the steamship *Canonbury,* which struck near the same spot in March, 1888, and was lost with her cargo—of a total value of $292,000.



WRECKING PUMP IN SERVICE ON THE SUNKEN STEAMSHIP DE RUYTER.

A Special Trim Calculation.

BY B. A. SINN.

As ships grow larger, the question of stability and trim becomes one of not nearly as great moment as in the smaller ships of some years ago, principally owing to the fact that the greater length, beam, and draft produce a much higher metacenter, and that the machinery, which is situated well down in the hold, and which forms a large part of the total weight, has a large negative arm which tends to reduce the center of gravity. This in effect produces a longer stability arm and a stiffer boat and consequently less motion due to rolling and pitching. Our modern steamers are therefore much more stable than those of former years.

The modern naval architects have consequently little to fear as long as the vessel is intact and under normal trim conditions. However, special cases may demand such arrangement of the interior as to make the vessel seem dangerous at first sight, if damaged or under circumstances of unstable equilibrium. Such a case passed under the writer's notice some two years ago, where, owing to an arrangement of hatches and holds, made necessary by the special cargo to be carried, a vessel of 500 feet length, 58 feet beam, and 40 feet molded depth had a forehold of over 120 feet in length, and the question as to the trim of this boat under a damaged or flooded condition of this hold made the calculations here shown necessary.

A careful figure of the center of gravity longitudinally was made and Bonjean curves drawn out and plotted, then curves of buoyancy for 16, 18, and 20-foot draft calculated, drawn as shown in Fig. 1. By cutting out a distance of length equal and in the position of the No. 2 hold, and integrating the residual, a displacement curve was drawn which showed the displacement at varying drafts with No. 2 hold flooded. Metacenter and center of buoyancy calculations were also made and the results plotted. As the displacement was known, it became an easy matter to find the corresponding draft and longitudinal center of buoyancy and metacenter from these curves. As the center of gravity was unchanged, and the center of buoyancy, displacement, and metacenter known, an approximation of the trim could be made. These figures showed a mean draft of 21 feet 3 1-2 inches and a trim of approximately 12 feet.

We now knew the limits of change, and, in order to arrive at more accurate results, we plotted from the Bonjean curves curves of sectional areas with about 5, 10, and 15 feet trim and for from 20 to 24 feet mean

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draft. These are shown in Fig. 2. Then by integrating these curves with No. 2 hold flooded and plotting the same, we have, as shown in Fig. 3, the range of displacement from 8,400 to 11,000 tons, and by figuring the centers of buoyancy we plot curves in three planes with variable trim, displacement, and centers of buoyancy.

By drawing a straight line from a point equal to 9,448 tons displacement (the condition of load presupposed), we immediately find, at the intersections of this line with the displacement and variable trim, points which in turn were plotted in Fig. 4.

At the point of intersection of a perpendicular in Fig. 4, at the center of gravity and the variable trim line we find that the center of buoyancy and center of gravity coincide when the vessel trims 12.67 feet by the head.

From Fig. 3 we see that the corresponding draft of 9,448 tons is 22.07 feet mean, which, with 12.76 feet trim, would bring her down to 28.45 feet forward and 15.69 feet aft. In this case at first sight it would seem that the vessel was in a precarious condition with the large hold flooded, and the first thought would be to affect the design of the vessel in some way to subdivide these large spaces. Further investigations show, however, that the vessel would not be further in the water at the stem under these conditions than she would be under ordinary load, consequently the vessel would be in no danger of foundering, and, further, if the three forward water-bottom tanks are pumped out, the trim becomes negligible, being less than 3 feet by the head.

Had these calculations not been made, a lengthy discussion between underwriters, shipbuilders, and shipowners would undoubtedly have occurred when the vessel was finished; as it is, it is clearly shown that in this particular case there is no danger. However, it is not to be assumed that this will generally hold for vessels of this size, and an accident to the forward collision bulkhead, which would fill the forward forepeak tank and No. 1 hold, will place the vessel in a far more dangerous condition, as the moment would be larger, although the body of water affected much smaller.

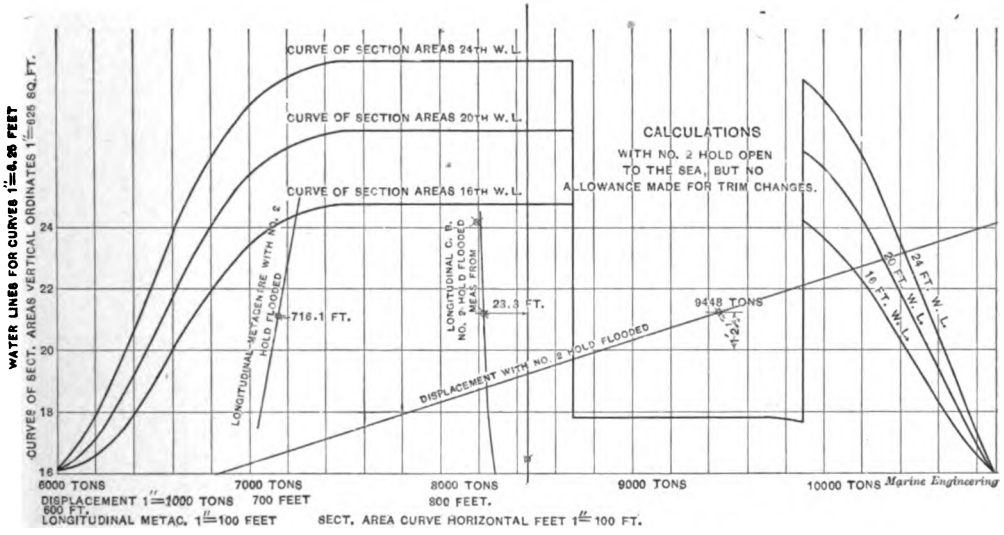

FIG. 1.

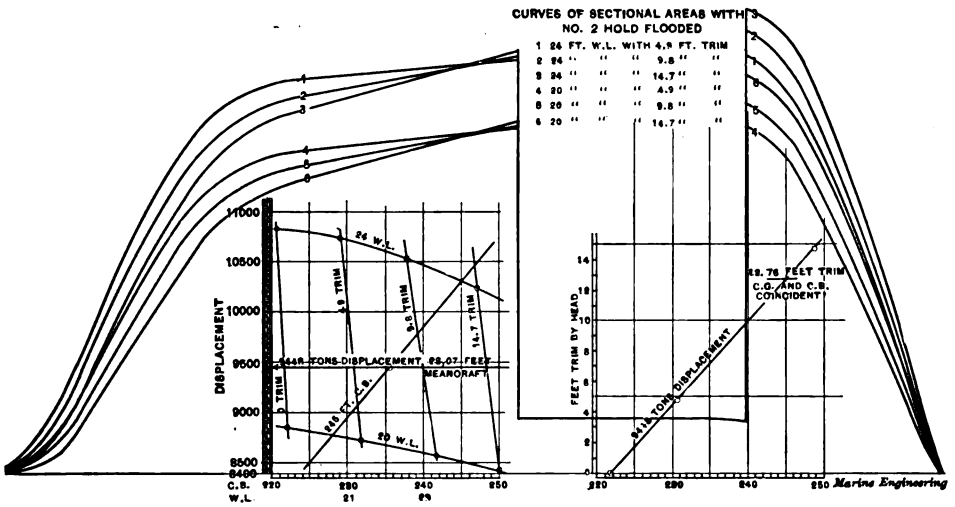

FIG. 2. FIG. 3. FIG. 4. FIG. 2.

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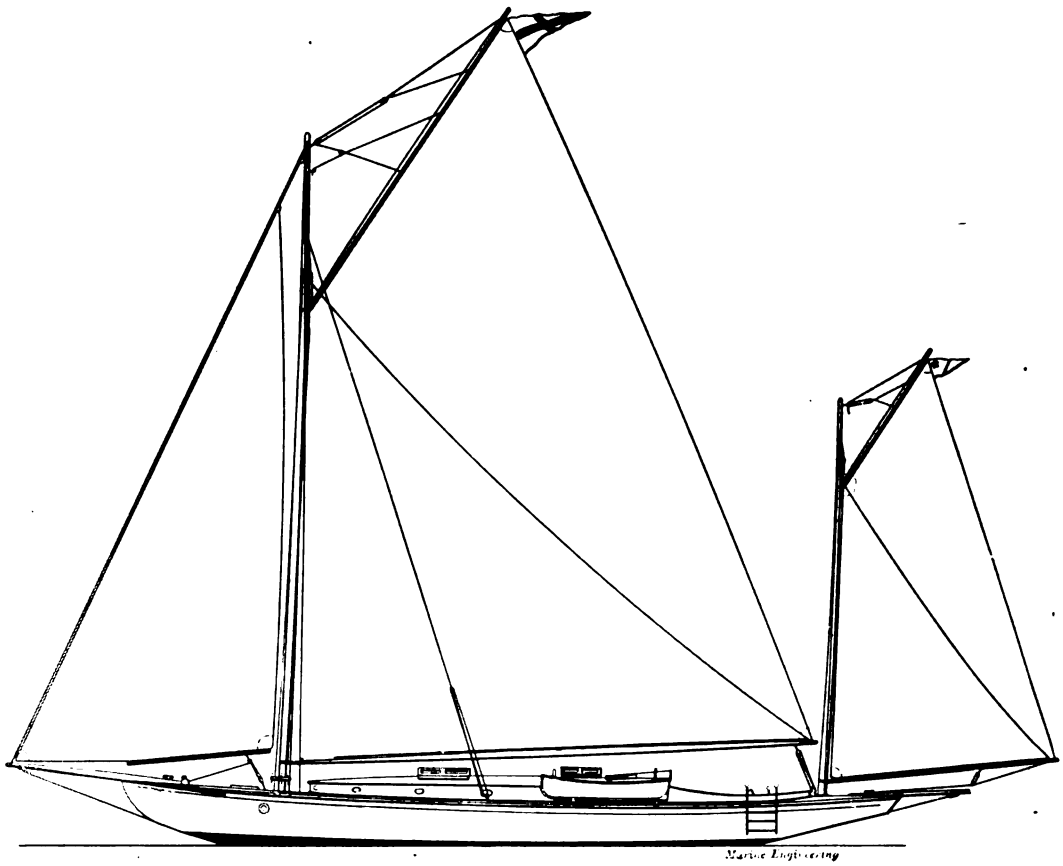
Under these circumstances the trim by the head would not be dangerous, except, in the case of a very severe storm, if a large quantity of water were to come down through the holds which would render the vessel unmanageable; but the modern steamers with deep tanks and water bottoms are so easily trimmed that ordinary caution is all that is necessary to keep them constantly safe in a transatlantic voyage.

Length and diameter of mast	51	ft. x 9 in.
Length and diameter of main boom	41	" x 5 "
Length and diameter of gaff	28	" x 4 "
Length and diameter of jigger mast	31½	" x 7 "
Length and diameter of jigger boom	18	" x 3 "
Area of mainsail	1,376	sq. ft.
Area of jigger	337	" "
Area of jib	398	" "



SAIL AND CABIN PLANS OF A SIXTY-FOOT AUXILIARY YAWL.

Sixty-Foot Auxiliary Yawl.

There was just completed at the works of the Electric Launch Company, Bayonne, N. J., a 60-foot auxiliary yawl named the *Naulahka*, and designed by the builders for Mr. R. Waverly Smith, of Galveston, Texas. The dimensions of this yawl are as follows:

Length over all	60	ft.
Length of load-water line	40	"
Beam	15	"
Draft without centerboard	3	"

The boat is designed for use in Galveston harbor and the construction is heavy throughout. The keel is of white oak, thoroughly through bolted. The frames are of oak, spaced 12-inch centers, held by heavy bilge clamps and floors. The deck is of white pine laid in narrow strips, calked, payed, and puttied. The planking is of yellow pine.

There is a large steering cockpit aft, with a level floor for accommodating chairs, as will be seen from the plan. The cabin is large, well ventilated, and has two skylights and twelve port lights, the transom seats form-

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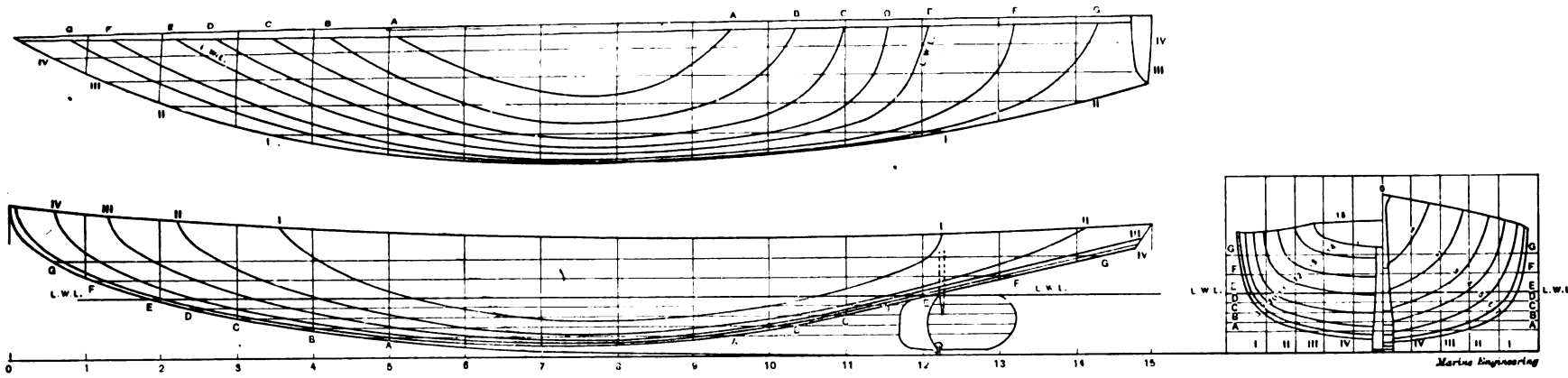

WATER LINES AND BODY PLAN OF SIXTY-FOOT YAWL DESIGNED AND BUILT BY THE ELECTRIC LAUNCH COMPANY.

ing berths 30 inches wide for accommodating four guests. The entire finish of the cabin is quartered oak, highly polished and finished with spar varnish.

The owner's state room is a large room with a double berth, folding washstand, bureau, mirror, etc., and adjoining it is a bath room furnished with a 60-inch tub and open type of yacht water closet. The galley is commodious and is equipped with an ice box, sink, and stove. In the forecastle are accommodations for a crew of two.

The yawl is equipped with a 14-horse-power, four-cylinder gasoline engine, with which a speed of 7 to 7 1-2 miles an hour can be obtained in smooth water. A gasoline tank with a capacity of 100 gallons is placed under the deck aft, there being a double bottom in this compartment draining overboard. This safeguard is taken to prevent the gasoline from running into the bilge if the tank should leak. A complete electric light and storage battery plant is installed, there being ten lights distributed throughout the cabin and also four electric fans to assist in ventilation. The power for running the dynamo is taken from the main engine, while the electric circuit may be connected to the storage battery when the engine is not running.

The *Naulahka* is handsomely finished, both outside and inside, and is completely equipped with furnishings, deck awnings, etc. On April 15 this staunch vessel sailed for Galveston, Texas, under her own power.

Gun Positions of the Battleship Maine.

An official report has been made by Capt. Eugene H. Leutze, of the new battleship *Maine,* about the condition of his vessel as a result of the "shaking down" cruise in the West Indies. Much has been said about the *Maine* in the daily newspapers to the effect that she was structurally weak, whereas Capt. Leutze's statement showed that the battleship has only developed weakness in the supports and placements of her 6-inch guns and in the foundations of her turrets. The cause of the giving way of the supports and rivets is due entirely to the increased muzzle energy of her guns, resulting from the use of smokeless powder. The turrets were designed in accordance with designs of previous battleships, which used ordinary brown powder.

Rear Admiral Bowles, the chief naval constructor, has issued a statement of the vessel's condition as follows:

The officers who have examined the turrets of the *Maine* have found that the damage done consists largely of the loosening up and breaking of fastenings and rivets in the circular structure underneath the rollers and paths on which the turret is supported, and in no respect due to general structural weakness of the ship. The supports under the roller paths are of the usual construction, being built up of plates and angles.

Since the date of the design of the *Maine,* however, the use of smokeless powder with higher pressure guns has been adopted and the recoils allowed have been shortened. Both of these improvements, while desirable of themselves, have greatly increased the strain on the supporting structure, which in actual test of firing has proven inadequate.

Were it not for the great weight of the revolving part of the turret, amounting to over four hundred tons, the fitting of the additional stiffening in the supports which has been decided to be necessary would not be a very elaborate work; but, owing to the great superincumbent weight which must be supported and the inaccessibility of the parts, it is anticipated that the repairs will take some little time.

The deformations of the decks in the vicinity of certain 6-inch guns, due to the same general cause, are much less important and can be easily remedied.

The chief constructor considers that no blame can be attached to the contractors for the *Maine,* as there was no evidence whatever of defective workmanship.

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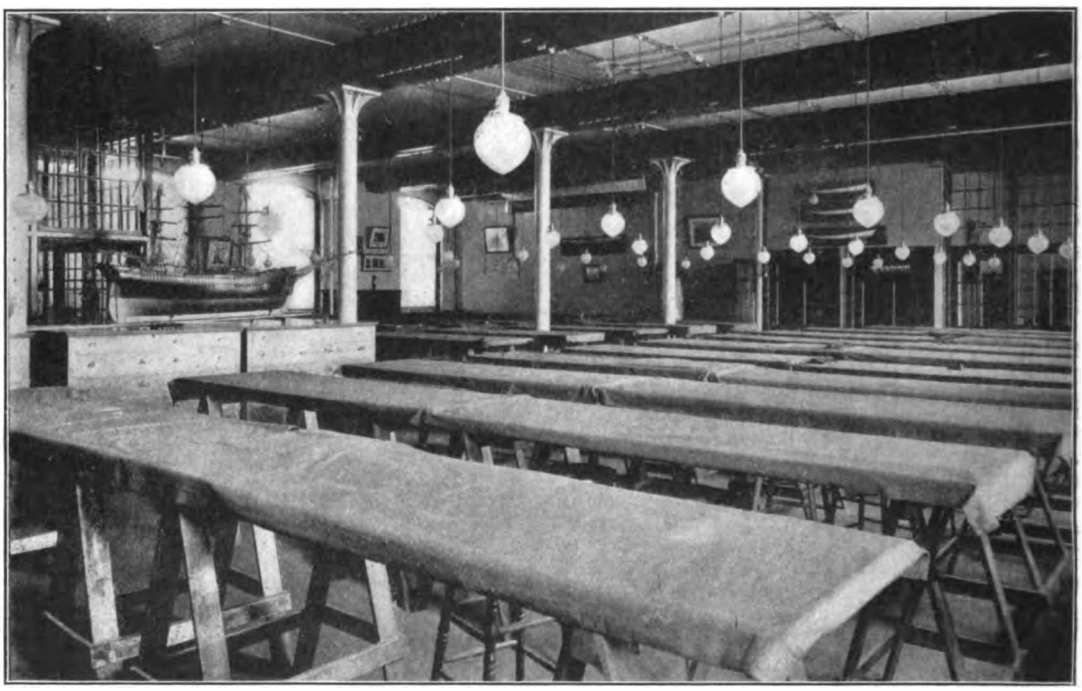
OUR SCHOOL FOR NAVAL CONSTRUCTORS.

When the chief European schools of naval architecture decided, a few years ago, to admit no more of the naval cadets of the United States who had borne off so many of their prizes, it was a fortunate stroke for naval science in America. Our government, thrown back on its own resources, looked the country over and determined that if its young naval constructors must be educated at home they should be educated here as thoroughly and broadly as was possible in the old and famous schools abroad. To undertake this large work the Navy Department chose the Massachusetts Institute of Technology in Boston.

This experiment—for such it was in its inception—began almost two years ago. The second group of naval cadets—or midshipmen, as they are now known—is completing its first year at the Massachusetts Institute, and five more midshipmen of high scholarly promise now enter the school to take such part of the year's work as is possible, and to make up the rest in the summer, so as to join the class which entered last autumn. The urgent demand upon the construction corps for the great number of new ships now building makes this addition imperative.

The young Annapolis men who take this course of elaborate instruction at Boston are selected from the classes that have finished a four-year course at Annapolis and passed one year at sea. They enter the junior year of the four-year course in naval architecture at the Massachusetts Institute of Technology, and take there the junior and senior years and one graduate year, which gives them the theoretical work of the whole regular four-year course in Boston and one additional year of theory. This advanced year has not yet been entered upon by the navy students, nor have its details yet been completely arranged.

Though this school of naval architecture is not an old one, it is firmly established and possesses an excellent equipment. It now has, all told, eighty or eighty-five students in its sophomore, junior, and senior years—an excellent representation out of the 1,600 students in the Institute. The growth of this school has, in fact, been rapid beyond anticipation. It has felt the influence of the swift advance in American shipbuilding and the increasing interest in the navy and maritime affairs throughout the nation. There are three Annapolis men in the senior and four in the junior class. These young men all come under the supervision of Prof. Cecil H. Peabody, who has long had charge of the department of naval architecture and marine engineering. The subject of warship design is especially in the hands of Prof. William Hovgaard, captain in the Danish navy, who was formerly connected with the Royal Naval College at Greenwich. Besides these two officers of the department there are Mr. Walter S. Leland, instructor in naval architecture; Mr. Allen L. Appleton, assistant in naval architecture; and Mr. Charles F. Willard, assistant in marine engineering.



MAIN DRAWING ROOM, NAVAL CONSTRUCTION DIVISION, MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

The work of warship design naturally fills more time than anything else with the Annapolis students. But they receive also instruction in steam engineering, marine engineering, applied mechanics, and electricity in the many and important forms in which it is now utilized in warships. There are also courses on sanitation, heating and ventilating, foundations, metallurgy and metallography. There are lectures, laboratory work on paints, oils, and other organic materials of ship construction, and from time to time the young men listen

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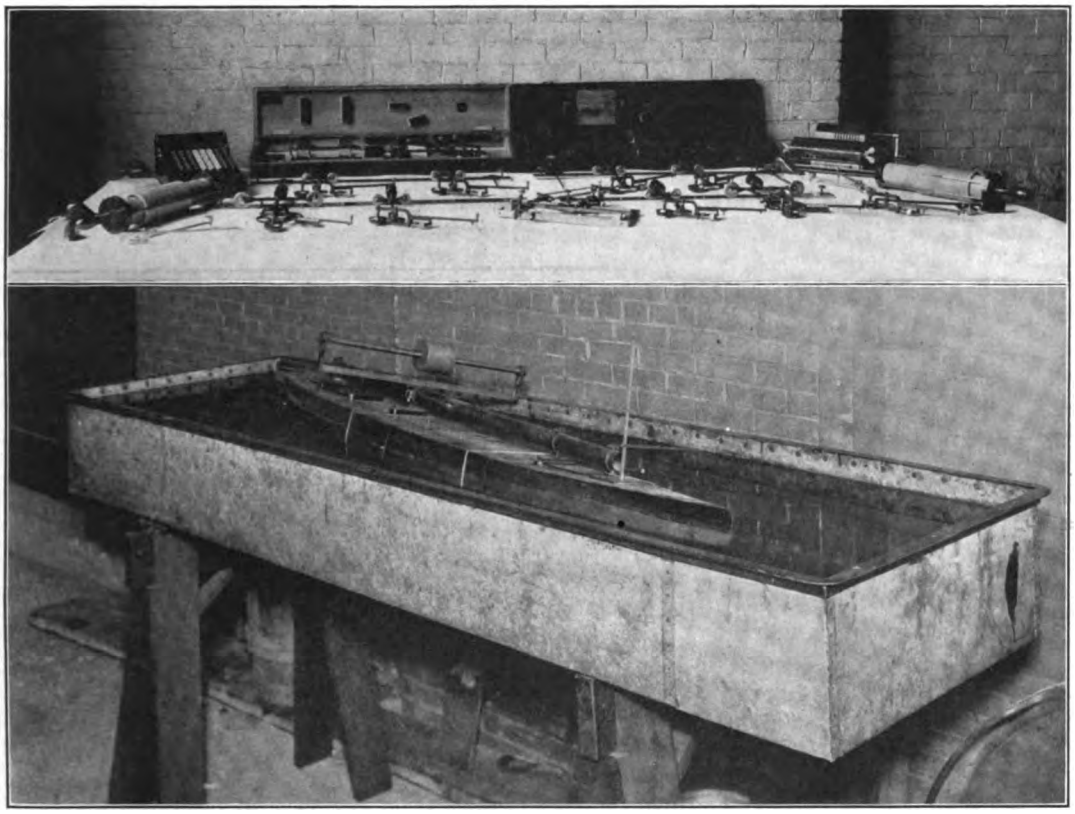
to addresses by naval constructors and other specialists on various themes of importance in naval architecture. The three-year course of the naval cadets, with its third year corresponding to the graduate work in other departments, leads up to the degree of Master of Science.

The general course of instruction is a broad one; it assumes that the result shall be a well-grounded scholar and gentleman. The midshipmen who are candidates for the construction corps of the United States navy come to Boston with an excellent foundation in the four-year course of study at Annapolis, supplemented by a year afloat on some cruising warship. The sea is not now a mystery to them, they have met and faced it, they know something of its bewildering caprices, its force, and its majesty; they are, in fact, already young sailors and are the better fitted by their short experience at sea to grapple with the problems involved in the complex art of modern naval architecture. Taking all together the summer practice cruises of the Annapolis course and the sea year that follows, these students have had a good opportunity to observe the actual behavior of ships in varying conditions of wind and weather. Here is good, solid, practical instruction for a beginning. In the school at Boston the aim is to work out that fine blending of the practical and theoretical which is requisite to enable the United States naval constructors to meet the constantly enlarging demands of an arduous profession.

Boston is an admirable location for a school of this kind; the Charlestown Navy Yard, its docks and its great workshops, are near at hand, and Boston harbor also holds at Quincy Point the fine new steel shipyard of the Fore River Ship and Engine Company, where much government work is now under way. Besides, Boston and the towns around are a perfect hive of industries of all kinds. Machine shops especially abound, and at South and East Boston there are several minor but excellent shipbuilding and repairing establishments. Moreover, the atmosphere of the neighborhood is distinctly maritime, and Boston merchants and shipowners are making a brave fight to regain their old prestige on the deep ocean. The port of Boston is crowded with deep-sea ships and coasters of widely varying types and tonnage, and there are, therefore, many opportunities for witnessing progressive speed trials, tests of engines and boilers.



INTEGRATORS, CALCULATING MACHINES, AND FLOATING MODEL OF SHIP IN TANK.

The department of naval architecture possesses an excellent library of standard works on naval architecture and marine engineering, and its students have free access to the greater libraries of engineering, physics, and chemistry and to the many and well-equipped laboratories of the Institute. Here the men are made acquainted with the laying out and fairing of the lines of the ship; and in carrying out the design, structure and arrangement are carefully studied. They are instructed in the ways of making the necessary calculations of displacement, metacentric height, longitudinal and transverse metacenter, stability, efficiency, etc. They are also instructed in the best processes of launching and of docking.

The work in marine engineering familiarizes the student not only with the history of marine machinery and the general theory of steam propulsion, but with the

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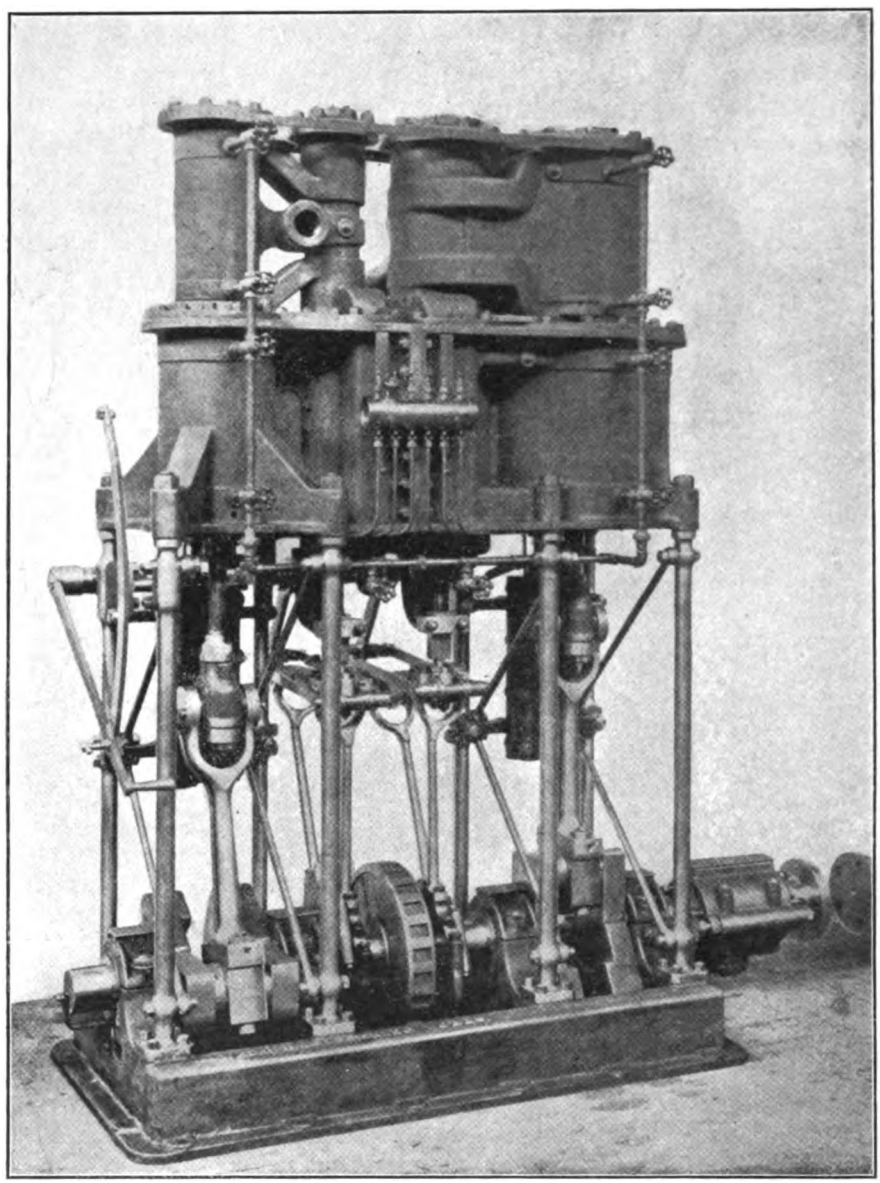
actual planning and working of modern engines of the best and most effective type. It is expected that the student, in connection with his theoretical work, will make exact drawings and calculations for the preliminary design of marine engines, thus applying thoroughly the principles which he has learned.

With the increase in the construction corps which must follow the steady increase of the United States navy, it will probably become necessary to send more and more of the Annapolis men to Boston for this elaborate course of instruction. The Massachusetts Institute of Technology is throughout a school of keen conscientiousness and broad ambitions, and these characteristics especially belong to the department of naval architecture. It is realized that the new task which the navy has set the Institute is an honor as well as a responsibility; that it enhances the fame of the Institute and that it makes it still more distinctly national. The direction of the work of the young naval constructors in Boston rests in strong, competent hands.



QUADRUPLE-EXPANSION, TWO-CRANK ENGINE OF THE OHIO AND KANAWHA RIVER TOWBOAT JAMES RUMSEY.

STEAM TOWBOAT RUMSEY.

Further particulars concerning the *James Rumsey*, which underwent such a unique test and was described in MARINE ENGINEERING for April, are forwarded by the designers and builders, Ward's Engineering Works, Charleston, West Virginia.

The vessel was built for the United States Army Engineer Corps for towing barges, dredges, etc., used in the improvements of the Ohio and Kanawha rivers. She is

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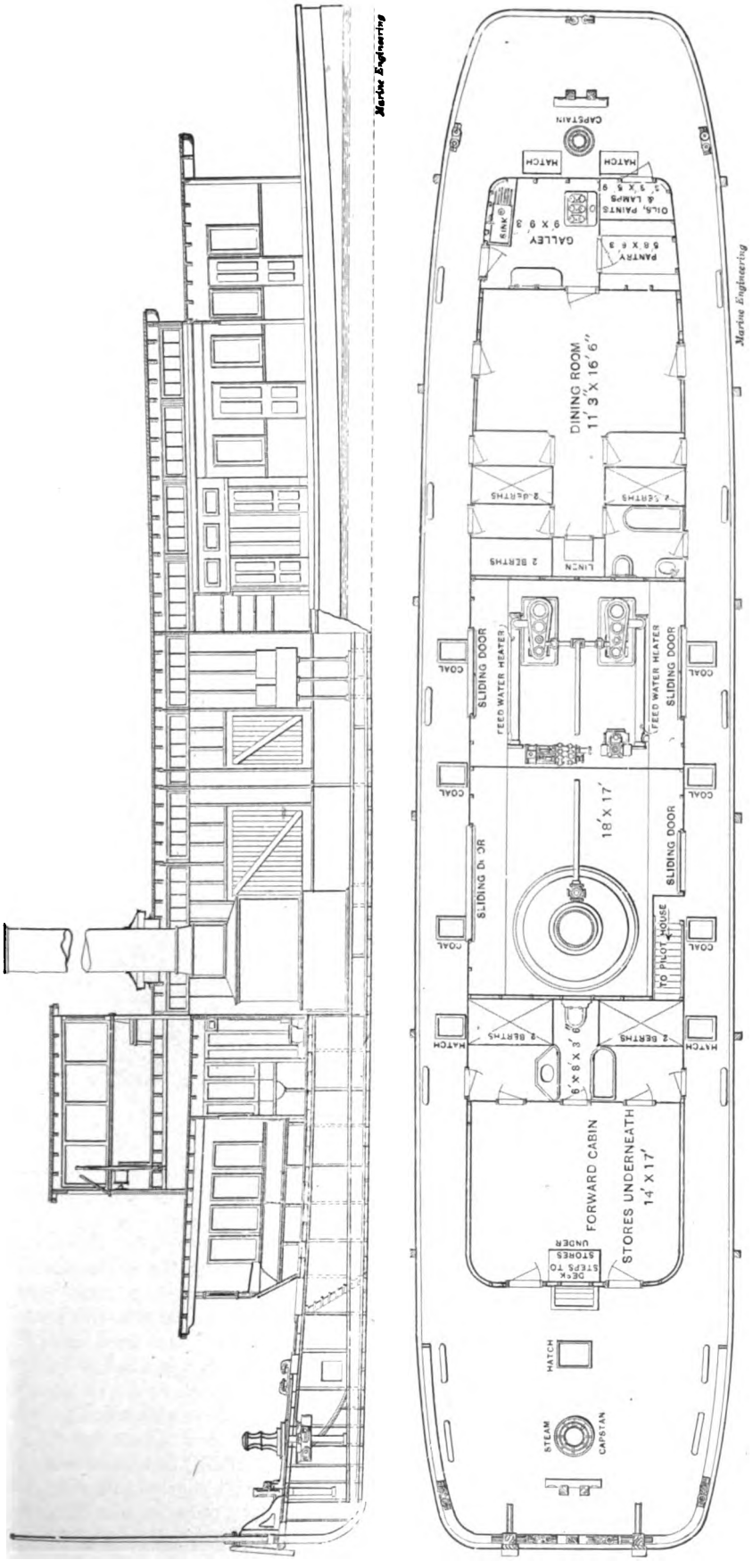

ELEVATION AND DECK PLANS OF THE TWIN-SCREW TOWBOAT JAMES RUMSEY, BUILT AT WARD'S ENGINEERING WORKS.

120 feet long, 22 feet beam, 4 feet 6 inches deep, and her displacement, light, is 100 tons, with a draft of 32 inches aft and 24 inches forward. The hull is built of steel throughout and is divided by four thwartship bulkheads, making five water-tight compartments. There are also two longitudinal bulkheads extending the full length of the boat.

The machinery occupies the middle compartment, which is 33 feet long, and on either side are coal bunkers with a capacity of 40 tons, which will carry the vessel 1,000 miles at a speed of ten miles. The machinery consists of a pair of two-crank quadruple-expansion engines, 7, 10, 14, and 20 inches by 12 inches stroke. The cylinders are mounted in pairs and upon a steel frame; the valves of the four cylinders are of the piston type, operated by Stephenson link motion; the crosshead and the slipper guide are of steel. It is seen from the engraving that this makes a very compact, strong arrangement. The high-pressure is above the first intermediate cylinder and the second intermediate is placed on the low-pressure. The cranks are 90 degrees apart and are counterbalanced. The contract requirement for the *James Rumsey* was that the engines were to develop 425 I.H.P., but the indicators have shown a maximum of 550 I.H.P.

The boiler is the regular Ward sectional-coil type and has 50 square feet of grate surface and 1,650 square feet of heating surface. The safety valve is set at 220 pounds,

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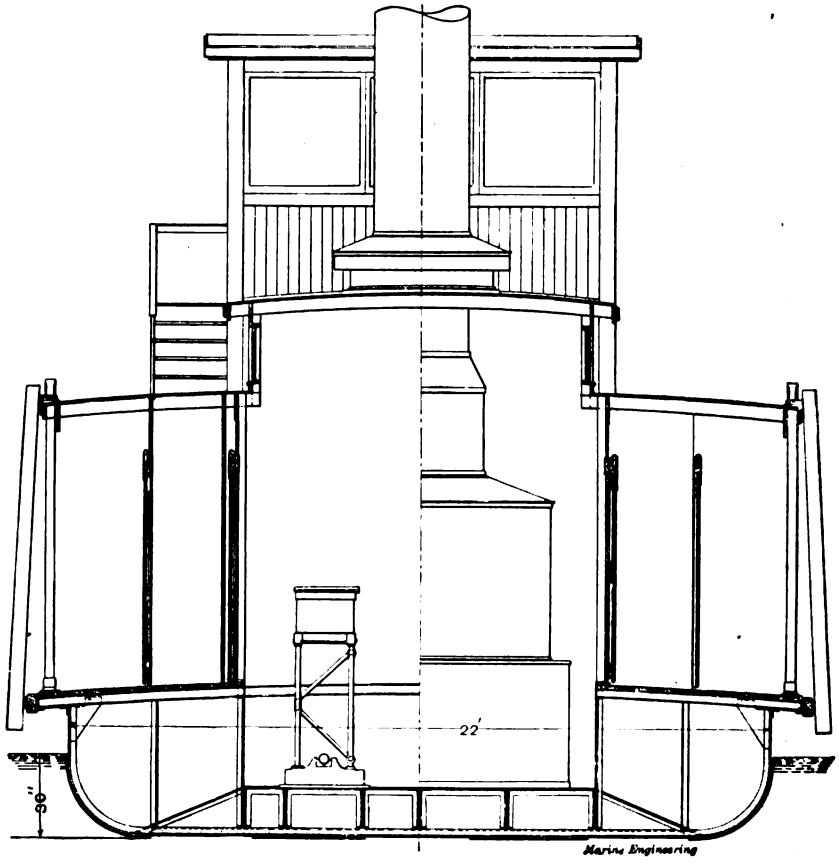
although the working pressure allowable is 250 pounds. There is a simple vertical light-weight air pump and a duplex outside-packed plunger feed pump. An outside sectional condenser is mounted on either side of the boat, one for each engine.

There are two four-bladed propellers, 4 feet 3 inches diameter, placed in tunnels near the stern, so that the tips of the blades are slightly above the bottom of the boat; thus, at rest the tops of the blades are 21 inches above the water line. Manholes placed over the propellers admit of their being changed or removed without docking the boat. When under way this tunnel is filled with water by the suction given by the screw, and thus the blades revolve in solid water.



MIDSHIP SECTION OF THE JAMES RUMSEY.

A special form of propeller is used, which is designed to give good backing power, as a large part of the work of this boat will be in backing, as well as towing and pushing. This is necessary in order to handle the large floats of coal which are taken down the river in barges. when going around bends or over the shoals; the tugboat then reverses her engines, holding back, while the current swings the tow in proper direction.

The contest described in the last issue with the *D. T. Lane* was most conclusive, as the latter vessel was recognized to be the best towboat of the old class on the river. By means of scales the *Rumsey* backs 75 per cent. as much as she pushes, while it was calculated that the stern-wheel vessel backs from 50 to 60 per cent. as much as she pushes.

The New English-Built Chilian Battleship Libertad.

The battleship *Libertad*, for the Republic of Chili, was recently launched by Her Excellency Madame de Gana, from the Naval Construction Works at Barrow-in-Furness of Vickers, Sons and Maxim, Ltd., shown in the accompanying illustration. The builders made a record for themselves in the length of time required from the laying of the keel to the launch. The keel was laid on April 7, 1902, and the ship was launched on January 15, 1903. The Chilian government placed the order for this ship complete in every particular, including armament, engines, and equipment. This, no doubt, is one of the reasons for the quick work. This custom is so different from that employed by our own department and the British Admiralty, wherein the contract is subdivided between different firms.

It is probable that the *Libertad* is one of the most powerful battleships of her size building, only a few of the more costly ships, of greater displacement, surpassing her. Her principal dimensions are as follows:

Length between perps	436 ft.
Breadth	71 "
Draft	24 " 7 1-2 ins.
Displacement	11,800 tons.
I. H. P.	12,500
Speed	19 knots
Armor plate	7 inches to 6 inches
Armor, gun positions	10 inches to 7 inches

The main battery consists of four 10-inch and fourteen

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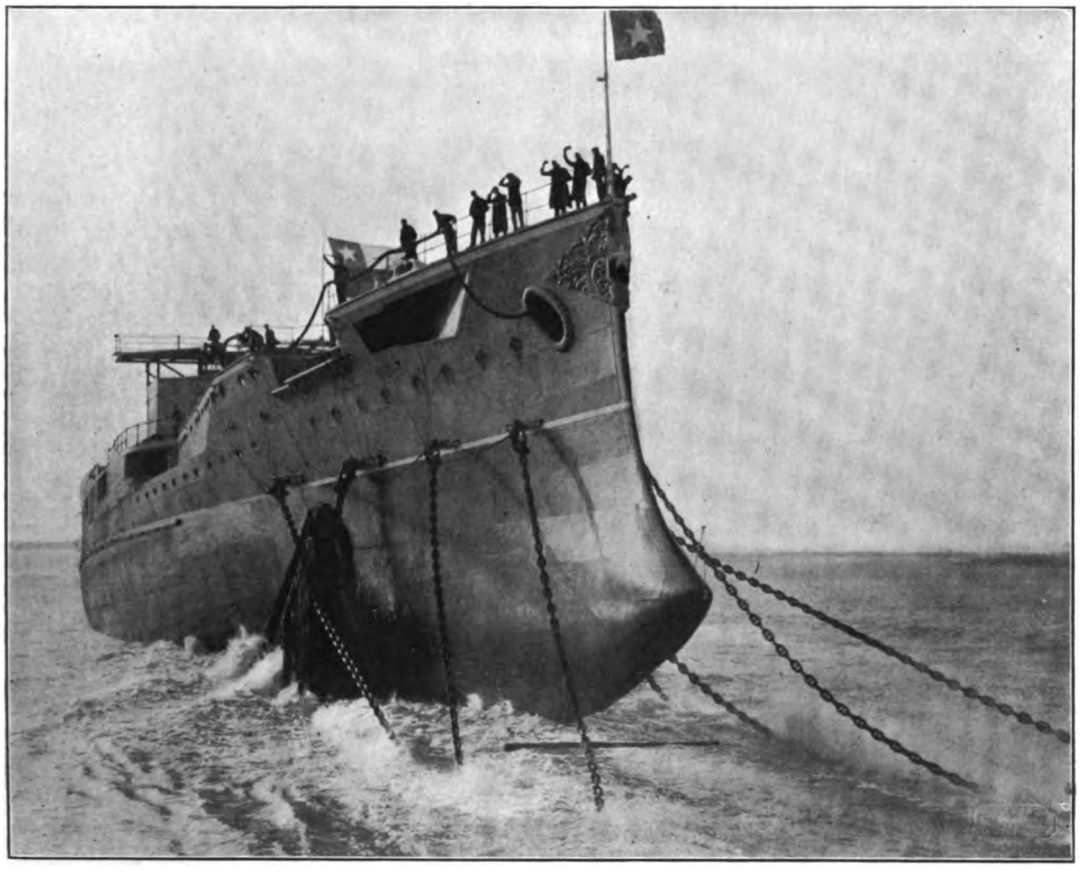
7-5-inch rapid-fire guns, and the secondary battery comprises fourteen 14-pounders, two 12-pounders, four 6-pounders, four 1-pounders, and four Maxim machine guns. These splendid fighting qualities have been provided, as will be noted, upon limited dimensions, and the high speed has been obtained without the sacrifice of armor or radius of action, as the ship carries fuel and supplies to enable her to steam 11,000 sea miles at 10 knots.

The following information is taken from *London Engineering:* The weight of projectiles from the whole of the ship's armament in one single round equals 5,846 pounds, or 427 pounds for each 1,000 tons displacement of the ship, while including only the primary guns the weight equals 407 pounds per 1,000 tons; and this can be said only of the new battleships of any other power. The round from primary guns in the latest French ships is 306 pounds, and of Russian and German ships 290 pounds per 1,000 tons.

The mechanism of the Vickers guns, too, gives a great rapidity of fire and high power from each round. Thus, in a minute the Chilian ship may fire from her primary guns 12 projectiles of 500 pounds = 6,000 pounds and 335,568 foot tons in energy; 98 projectiles of 200 pounds = 19,600 pounds and 1,186,584 foot tons in energy; total, 110 projectiles = 25,600 pounds and 1,522,152 foot tons of energy. From each broadside there can be fired per minute 12 projectiles of 500 pounds and 49 of 200 pounds, a total of 15,800 pounds, with an aggregate energy of about 928,800 foot tons. Each 500-pound capped shot could perforate, at half a mile range, the broadside armor of any ship afloat; while the 200-pound shot could perforate 6-inch armor at 1,000 yards range.

When chasing the enemy the ship can fire ahead each minute 6 projectiles of 500 pounds and 56 of 200 pounds, in all 14,200 pounds, with a collective energy of about 845,900 foot tons.

This ship has also an immense gun power against torpedo or submarine boat attack. Her smaller guns fire per minute 280 projectiles of 14 pounds, 112 of 6 pounds, 1,200 of 1 pound (pompoms), and 2,000 rifle bullets, so that the enemy, once discovered, would have little chance of escape.



LAUNCH OF THE CHILIAN BATTLESHIP LIBERTAD, AT THE WORKS OF VICKERS, SONS AND MAXIM, LTD.

The defensive qualities of the ship are equally satisfactory. Armor manufactured at the Sheffield works of the company, according to the latest process, forms a citadel in the center of the ship, and within this are ten of the 7.5-inch guns. In addition to the 7-inch armor forming the citadel walls, there are armored partitions separating the guns, so as to localize the damage from such shot as may find its way into the ship. The main armor extends for the full length of the ship on the water line, being reduced to 3 inches near the ends. Four of the 7.5-inch guns are in casemates of 7-inch armor on the upper deck, and the 10-inch guns are in 10-inch armored barbettes at the forward and aft ends

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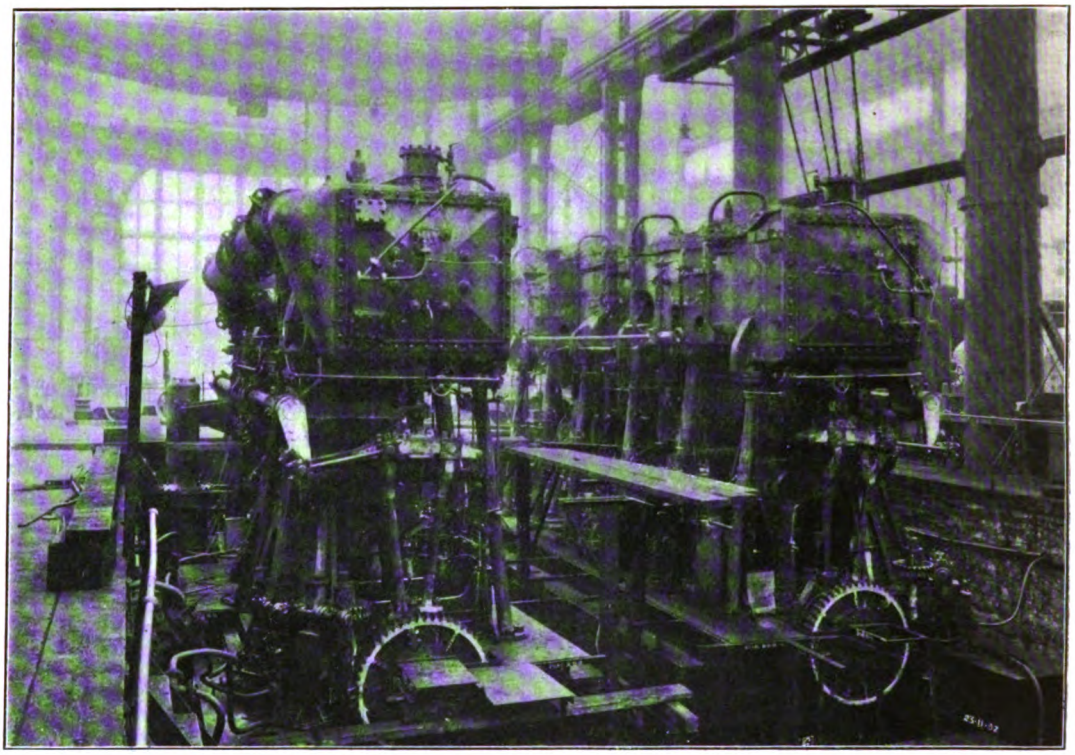
of the ship. The smaller guns, while sheltered, are in positions to command the enemy from all points. In action the ship and all the guns may be controlled from a conning tower built of 11-inch armor.

When completed, this vessel and her sister ship, both constructed under the direction of Sir Edward Reed and Admiral Simpson, will certainly constitute the finest fighting machines in South American waters, and will carry all the latest scientific inventions for signaling and other purposes, as supplied to the latest ships of European navies. She is a sister ship to the *Constitucion*, which was launched a short time ago for the Chilian government by Armstrong, Whitworth and Company from the Elswick shipyard at Newcastle.



TRIPLE-EXPANSION ENGINES FOR THE CHILIAN BATTLESHIP LIBERTAD.

It is stated that from the heavy battery on the battleship, with all of the guns firing at their maximum speed, a total of thirteen and a half tons of metal will be delivered in one minute, with a combined energy of nearly two million foot tons.

A few particulars of the launch of this ship are as follows: The standing ways were 550 feet long and of such width that the total launching weight of 6,700 tons, including cradle, was reduced to 1.64 tons per square foot. The inclination of the standing ways was 12-32 inch per foot. Forty-eight seconds elapsed from the first movement until the vessel was afloat, and from that point the ship traveled 195 feet, when she was brought to a stop, although there was plenty of width and depth of the waterway to allow for a long run. The vessel was pulled up by drag chains weighing in all 400 tons. As will be seen from the engraving, there are four chains on each side and these came into operation at successive stages in the ship's downward course. An additional stern drag anchor was firmly bedded in shore and connected to the ship's quarter by a 7-inch flexible steel wire rope, which came into play at the end and brought the vessel to a standstill. The anchor was found to have dragged a distance.

Large Anchors.—The anchors to be used on the warships *Tennessee, Washington, Connecticut,* and *Louisiana* have been ordered to be made at the Charlestown Navy Yard, Boston, Mass. Each of the ships will be given four of these anchors, weighing 17,600 pounds each, and four stud-link chains of 3 3-16-inch metal. This work is under the charge of the Equipment Department, which is also turning out anchors and chains for other battleships. In fact it is stated that every chain for the United States warships comes from the Charlestown Navy Yard.

Nine Months' Shipbuilding Returns.—The Bureau of Navigation reports 418 sail and steam vessels of 230,187 gross tons built in the United States and officially numbered during nine months ended March 31, 1903. The wooden tonnage, half of which was built on the Atlantic and Gulf, amounted to 22,324 gross tons, while of the steel tonnage 67,767 gross tons were built on the Atlantic and Gulf and 60,646 gross tons upon the Great Lakes. During the corresponding nine months a year ago there were 949 sail and steam vessels of 245,068 gross tons built in this country and officially numbered, showing a falling off of 4,108 tons of wooden construction and 14,881 tons of steel.

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A COMPARISON OF THE TRIALS OF THE NEW MONITORS OF THE UNITED STATES NAVY.

Of the four monitors authorized by Congress a few years ago, all have now run their acceptance trials, and the results form such a valuable contribution to the vexed subject of propeller design that we have compiled the following summary from the detailed reports given in the last two numbers of the *Journal of the American Society of Naval Engineers,* and through the courtesy of Rear Admiral Geo. W. Melville.

The general dimensions of these vessels, which are all alike, will be found at the bottom of this column.

sions of the propellers, as recommended by the Bureau of Steam Engineering, are given in Table I.

The areas are for one wheel only. The screws of the four monitors were true pitch.

The *Nevada* was tried off Cape Ann, one run each way, over a course of 13.2 nautical miles. The *Arkansas* ran standardization trials on the Barren Island course, and her two-hours acceptance trial took place off Cape Henry, in free route, in the open sea. The *Wyoming* standardized her screws in San Francisco bay and made her two-hours speed trial in "the open sea." The *Florida* was run over a measured course in Long Island sound and at one speed only.

TABLE I.
PROPELLER DATA OF MONITORS.

	Screw Proposed, Bureau Steam Engineering.	*Wyoming.*	*Arkansas.*	*Nevada.*	*Florida.*
Diameter, feet	9.0	8.0	9.0	9.23	8.5
Pitch, feet	8.28	8.49	7.25	7.80	8.32
Pitch ratio	.92	1.06	.85	.85	.90
Developed area, sq. ft.	28	25.8	25.6	24.0	26.0
Projected area, sq. ft.	24	21.2	22.6	21.0	22.0
Disc area, sq. ft.	63.6	50.3	63.6	66.6	58.1
Developed area / Disc area, per cent	.....	51 3	40.2	36 0	44.7
Diameter of hub, inches	.....	26.8	24.8	24	.....

TABLE II.
TWO-HOURS ACCEPTANCE TRIALS.

	Arkansas.	*Wyoming.*	*Nevada.*	*Florida.*
Revolutions, starboard	197.9	201.3	186.46	199.61
" port.	196.3		188.19	
I. H. P. main engines	1717.38	2325.71	1942.37	2317
Speed, knots	12.713	11.8	13.039	12.4
Slip, starboard	9.91	29.72	9.16	24.45
" port.	8.97	30.42	9.99	
Steam at boilers	204	227	239	.....
" " engines	146	216	189	.....

Length of load-water line	252	feet
Beam at water line	50	"
Draft to water line, normal	12.5	"
Corresponding displacement	3,218	tons
Block coefficient	.715	
Area of immersed midship section	597	sq. ft.

The *Wyoming* was run at the above draft and displacement, the *Arkansas* at 12.6 feet draft and 3,233 tons displacement, but the figures for the *Nevada* and *Florida* are not given. It is, however, unlikely that any but a small variation would be tolerated in a naval vessel of this class, and for practical purposes we may consider the hulls and therefore the resistances of these vessels as identical.

The dimensions of the engines are 17, 26 1-4, and 40 inches by 24 inches stroke. Each vessel had two of these engines, driving three-bladed twin screws. The dimen-

ARKANSAS—STANDARDIZATION TRIALS.

Number of Run.	Direction.	Revolutions per Minute.	Speed in Knots.	I. H. P. Both Main Engines for Each Round Run.
1	S	81.61	5.831	119.11
2	N	68.69	3.786	
3	S	121	8.803	403 09
4	N	120.35	7 997	
5	S	165.30	10.490	932.35
6	N	165 56	10.692	
7	S	212.26	12.470	2189.86
8	N	216.74	12.955	

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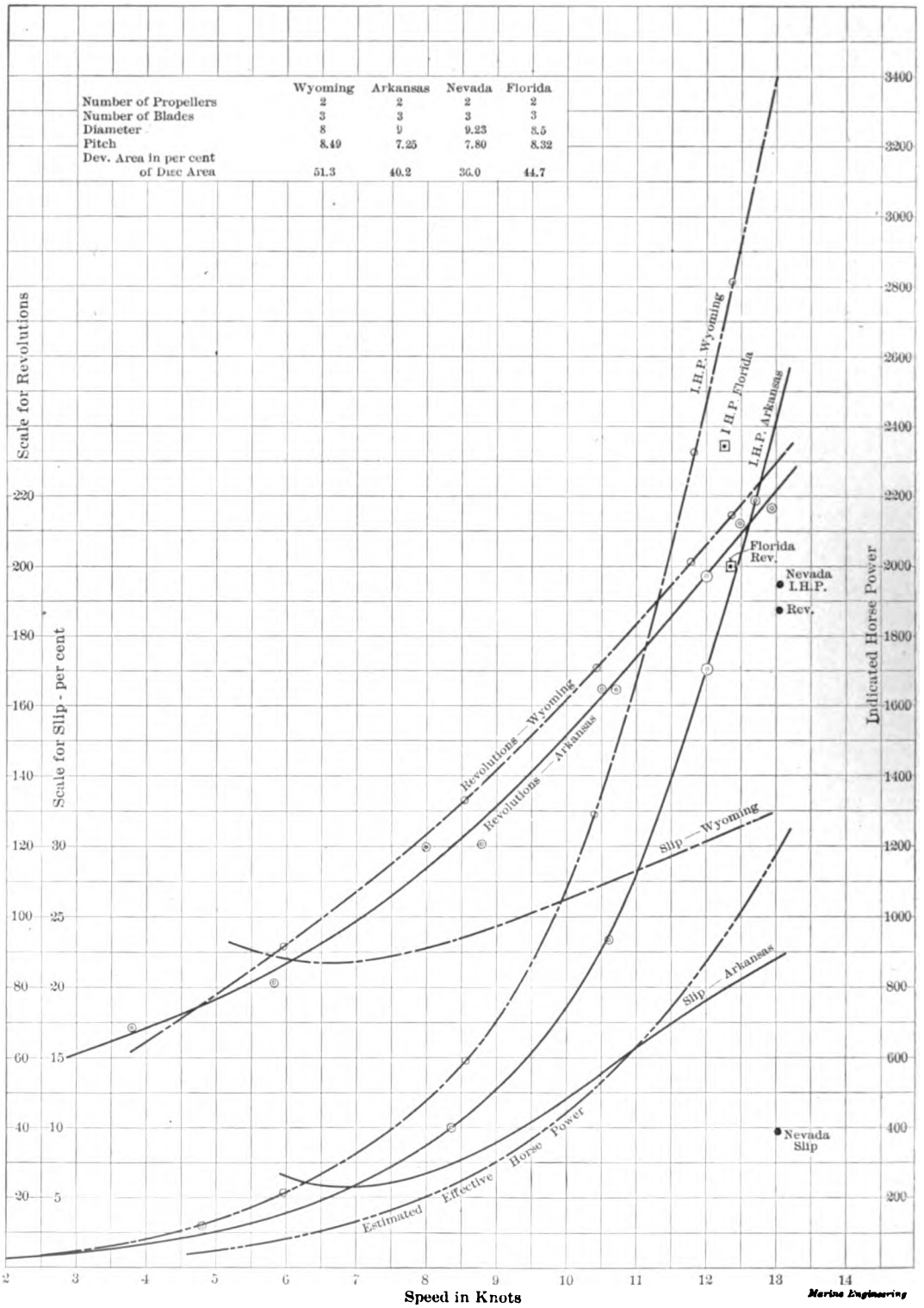
It will be noted from the preceding Tables I. and II. that, with the two propellers having about the same diameter as that proposed by the Bureau of Steam Engineering, the efficiency increases as the pitch rises toward that given for the proposed propeller, while with the two smaller propellers the efficiency increases as the diameter is increased and as the pitch decreases toward that of the Bureau's propeller. All propellers are slightly under the area that the Bureau considered necessary. It is well to note here that as the contractors alone are



CURVES OF HORSE POWER, REVOLUTION, AND SLIP FOR OFFICIAL TRIALS OF THE UNITED STATES MONITORS.

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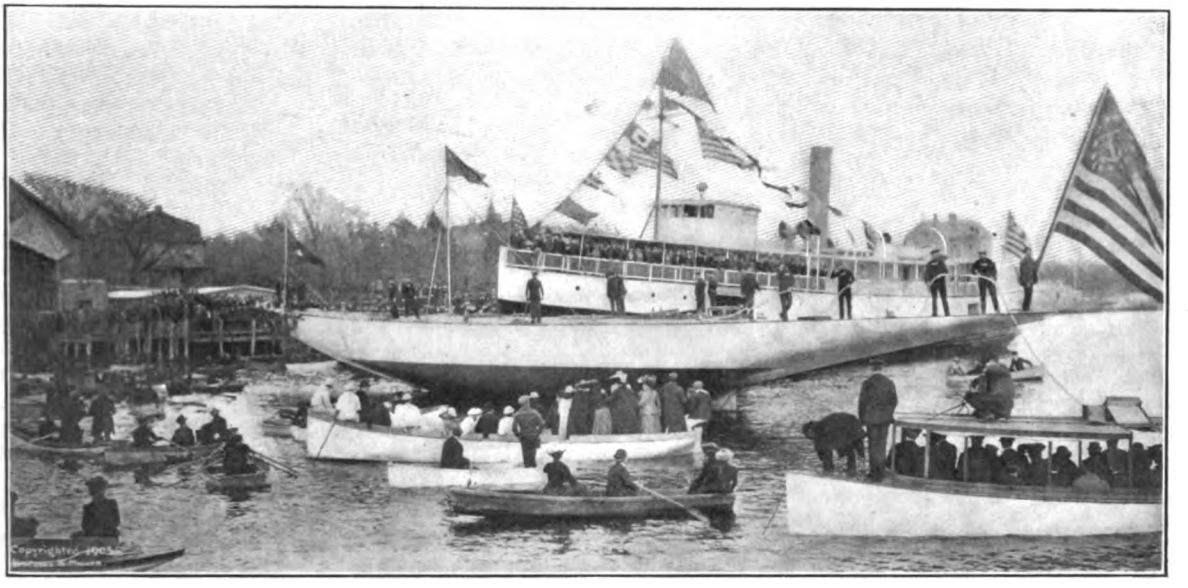
responsible for obtaining the contract speed of the vessels upon trial, the propellers are designed by the contractors. However, when a plan is submitted to the Bureau which is not radically wrong, it is allowed, and, at the same time, the contractor is advised what the Bureau considers to be preferable dimensions for the propellers. Should the

WYOMING—STANDARDIZATION TRIALS.

Double Run.	Rev. per Min.	I. H. P.	Mean Speed in Knots.
1	91.5	211.55	5.97
2	134.2	589.99	8.57
3	170.5	1295.50	10.40
4	214.7	2811 01	12.37

official trial took place on Long Island sound, off Stratford Shoal light, over a course of twelve nautical miles, marked by stakeboats and buoys at the ends and in the middle. The trial run consisted of a preliminary run in one direction over the course, not timed, and was followed by the official run over the course and return. It is stated by the builders that, owing to very thick weather on the official run, the last lap was steered almost entirely by compass, and on all of the runs half the distance, six miles, from buoy to buoy, was passed before the pilot was able to pick up the next buoy. As the vessel is fitted with a liquid compass, which was at the time more or less imperfectly compensated, the steering of the monitor was not satisfactory, and it is probable that the vessel lost considerable speed through yawing.

There was possibly a slight error in the speed of the



LAUNCHING THE NEW CUP DEFENDER RELIANCE, AT BRISTOL, R. I.

[Photograph copyright, 1903, by Hastings and Miller.]

Navy Department insist on furnishing the propeller designs, in the event of a ship's not attaining contract speed the contractor would be relieved of responsibility.

From these tables are drawn the curves of the accompanying diagram for the *Wyoming* and *Arkansas*, the lack of data preventing drawing curves for the other two monitors. There is also added to the figure a curve of assumed effective horse power, drawn according to Taylor's formula, which is of course only an approximation, but helps to give an idea of the magnitude of the power losses. It is roughly confirmed at 13 knots, as it gives a propulsive efficiency of 61 per cent. for the *Nevada*, and judging by the other boats her performance was extremely good. The contract speed of 11.5 knots was obtained with 2,060 I.H.P. on the *Wyoming*, 1,400 with the *Arkansas*, and how much more or less in the other cases we do not know. The *Nevada* attained a speed of 13 knots upon 1,942 I.H.P., and in the other vessels this speed would have apparently been obtained with 3,390, 2,420, 2,800 I.H.P., respectively.

The *Florida* did not run standardization trials, and the *Nevada* by which her apparent speed may have been increased, as the buoys marking the course of the trials were laid down several days prior to the trials, and bad weather existed between the time the buoys were placed and the date of the trials. There is no doubt, however, that the greater part of the differences in the speed performances of these vessels was due to the propellers alone. The large amount of slip occurring with the smaller wheels was especially harmful under existing conditions of fine pitch ratio and a very full vessel. The horse powers varied directly as the diameters.

According to Froude's experiments such a vessel might be expected to have a wake factor of fifteen to twenty per cent.; that is to say, that the water in which the propellers work has had imparted to it by the friction of the hull an average speed of one-fifth the speed of the vessel. Froude found that, with ordinary values of slip, the suction of the propellers was balanced by the gain in thrust due to this forward motion of the wake, but it certainly here appears that the high slips increased the resistance far above the gain due to the wake.

It would be interesting to know what was the depth

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of water for the standardization and two-hour trials, as this may in part account for the superiority shown by the *Nevada*. It is to be hoped that this article will elicit communications from those who are acquainted with the details of the trials, of the propeller designs, or in fact any facts which might lead to this abnormal difference.

Reliance Overboard.

The new cup defender *Reliance* was launched slowly and without a hitch of any kind from the Herreshoffs' yard at Bristol, R. I., on April 11. The launch took place just before sunset, and as the 90-foot yacht slid into the water she was for the first time seen by the outside world. The speed of the launching cradle was regulated by blocks and fall, so that it took just eleven minutes from the time the yacht started, when she was christened by Miss Nora Iselin, to the time she was water borne. Two minutes elapsed after the vessel began to move down the ways before the first part of her hull touched the water. The onlookers had plenty of time to see the hull before it was immersed, and the general impression seems to be that the *Reliance* will be an exceptionally speedy boat. It is stated that the new yacht is a radical departure in design from the *Columbia* and *Constitution*, and in the proper directions. She has great beam, and the increased after overhang tapers off to a fine point. The bilges are higher and the floors flatter than in the previous defender. Although she is termed a scow, her lines are most graceful in every point, and experts say that the bow and stern will be a great advantage in smooth water and light breezes. There are seven strakes of tobin bronze plates from the rail to the fin. The general dimensions are said to be: "Length over all, 141 feet, on water line 89.92 feet; beam, 25 feet 9 inches; draft, 19 feet 9 inches; estimated sail area, 15,000 square feet; the mast is to have only one pair of spreaders." While the above figures may be approximate, they are not to be considered reliable.

Institute of Naval Architects.

In 1903 the session of the Institute of Naval Architects was held in the hall of the Society of Arts, London, on April 1 to 3. The following papers were read and discussed:

1. The Effect of Modern Accessories on the Size and Cost of Warships. By W. H. Whiting, assistant director of naval construction, member.
2. The Lines of Fast Cruisers. By Vice-Admiral C. C. P. FitzGerald, associate.
3. The Training of Engineers in the United States. By Professor W. E. Dalby, M.A., B.S., associate.
4. The Modification of the Mean Pitch Due to Twisting the Blades in Screw Propellers. By Professor Angelo Scribanti, member.
5. Gradual Collapses of Furnace Crowns: A Suggested Explanation. By H. M. Rounthwaite, member.
6. The Ljungstrom Condenser as Applied to Marine Purposes. By W. Cross, associate.
7. The Screw as a Means of Propulsion for Shallow-Draft Vessels. By A. F. Yarrow, Vice-President.
8. The Ballasting of Steamers for North Atlantic Voyages. By S. J. P. Thearle, member of council.
9. On Marine Installations for the Carriage of Refrigerated Cargoes. By R. Balfour, engineer surveyor of Lloyd's Register.
10. Fitting Out Wharf Crane Service in American Shipyards. By W. A. Fairburn, member.
11. On Corrosion in Metal Pipes on Board Ship. By A. W. Stewart.

The Plymouth-City of Taunton Collision.

A serious collision took place on Long Island sound near Fisher's Island on March 20 between the two Fall River Line steamers, the *Plymouth*, bound east, and the *City of Taunton*, bound west. A heavy fog existed at the time and those in the pilot house of the *Plymouth* did not hear the *City of Taunton's* whistles until almost upon her.

The *Plymouth* is a steel ship with a complete watertight double bottom, while the *City of Taunton* is a wooden vessel. The *Taunton* struck the *Plymouth* on the starboard side a little aft of the pilot house, cutting through the guard and deck, ploughing into the side plating. As the *Taunton* drew away her stem ripped through the forward cabins, as shown in the accompanying cut. The compartment of the *Plymouth* which was thus opened to the sea contained the quarters for the crew. Four of them and one passenger were drowned; another member of the crew was killed outright. The collision tore away the entire bow of the *Taunton* down to her forefoot. Fortunately the collision bulkhead was not damaged. The steamboat *Nashua* towed the *Taunton* stern first into New London, where the *Plymouth* had already proceeded under her own steam. The sworn statement of Captain Bibber, of the *Taunton*, is as follows:

"Westbound March 19, had thick fog from Rose Island. About ten minutes to 12 P. M. I heard the *Plymouth's* whistle one and a quarter knots on the port bow. We stopped and blew three whistles. The *Plymouth* sounded about one and a quarter points on the port bow. We started ahead under one bell and hauled into west one and a quarter north, and, as the *Plymouth* did not widen out, we hauled into west by north three-quarters north. When I found he was coming on at us, I ordered the engines stopped and backed full speed. Just at that time I saw his green light about two points on the port bow. At five minutes past 12 A.M., the 20th, we collided, carrying away all the bow."

Captain Davis, of the *Plymouth*, made this statement:

"Left New York March 19, at four minutes after 5 P.M. The wind was moderate from the south. Thick weather. All went well until Gull Light was passed. Second Pilot Hambly was at the window. I sat just back of the starboard window. I heard one blast of a steam whistle. At the same time the pilot rang the stop and back-at-full-speed bells.

"I saw the headlight of the steamer *Taunton* off our starboard bow close to us, and in an instant she struck us head on, cutting through our guard and into the hull, so that our forward section filled with water, drowning three colored men, employees of the boat, and one white watchman. The impact stove our saloon deck and four state rooms, injuring one passenger, who died soon after the collision. Some few were slightly injured. The damage to the hull of the *Plymouth* is estimated at $20,000."

United States Steamboat Inspectors Withey and Daboll, of New London, have reported to Supervising Inspector Robert S. Rodie as follows upon the facts they have learned as to the collision between the steamers *Plymouth* and *City of Taunton* last month:

The cause of the collision between steamer *Plymouth*, Elijah G. Davis, master, and *City of Taunton*, John S. Bibber, master,

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which occurred on the waters of the Race, on the morning of March 20, 1903, has been investigated by this local board and we hereby submit the following statement of our findings in the premises, to wit:

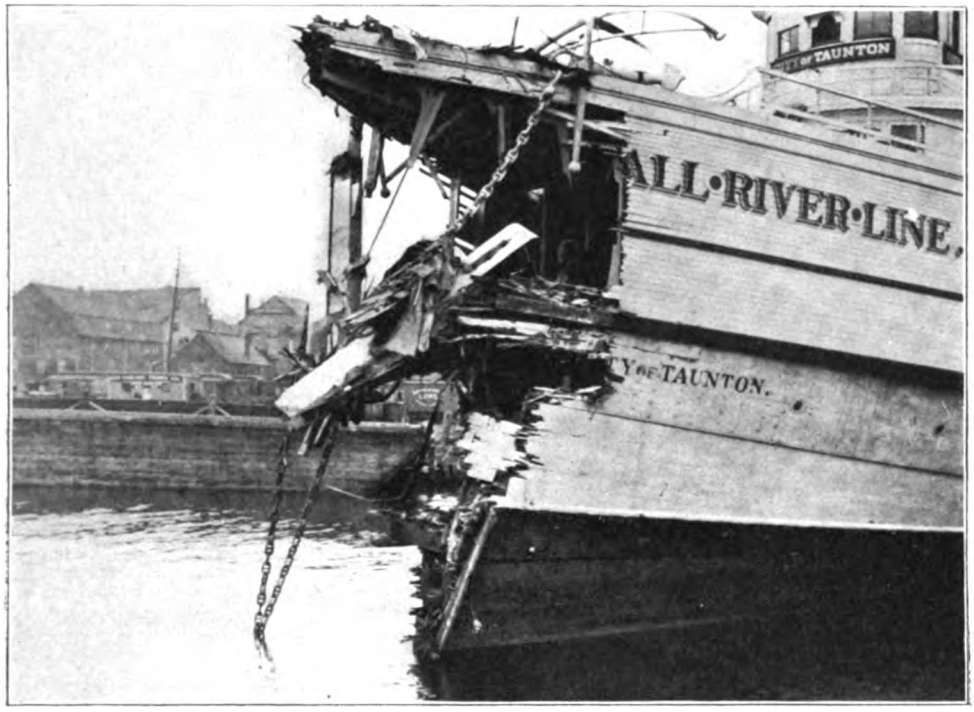
The evidence adduced in this case is deemed sufficient to show that these steamers were in charge of officers eminently fitted by long experience to perform their duties in an able manner. Dense fog prevailed; objects at a short distance were completely hidden; an atmospheric phenomenon known to, and frequently encountered by, master mariners, but as yet not explained by physical science, existed, viz.:

First. Where sounds given in fog from one direction fail to penetrate the atmosphere at an opposite point.

Second. Where sounds given in fog are distinctly heard, yet cannot be accurately located.

Under such conditions steamers *Plymouth* and *City of Taunton* did, on said date, approach each other on opposite courses. *Plymouth's* whistle was heard by *City of Taunton's* master, but its true bearing was inaccurately located; at an estimated distance of 500 feet away, master of *Plymouth* heard the *City of Taunton's* whistle sounded once only, and at the same instant distinguished her lights; with engines backing full speed the two steamers collided. We find the masters of the steamers not guilty of misbehavior, negligence, or unskillfulness, and do hereby exonerate them from all responsibility.

W. E. WITHEY, CHARLES M. DABOLL, Local Inspectors.



THE STEAMERS PLYMOUTH AND CITY OF TAUNTON AFTER COLLIDING IN LONG ISLAND SOUND.

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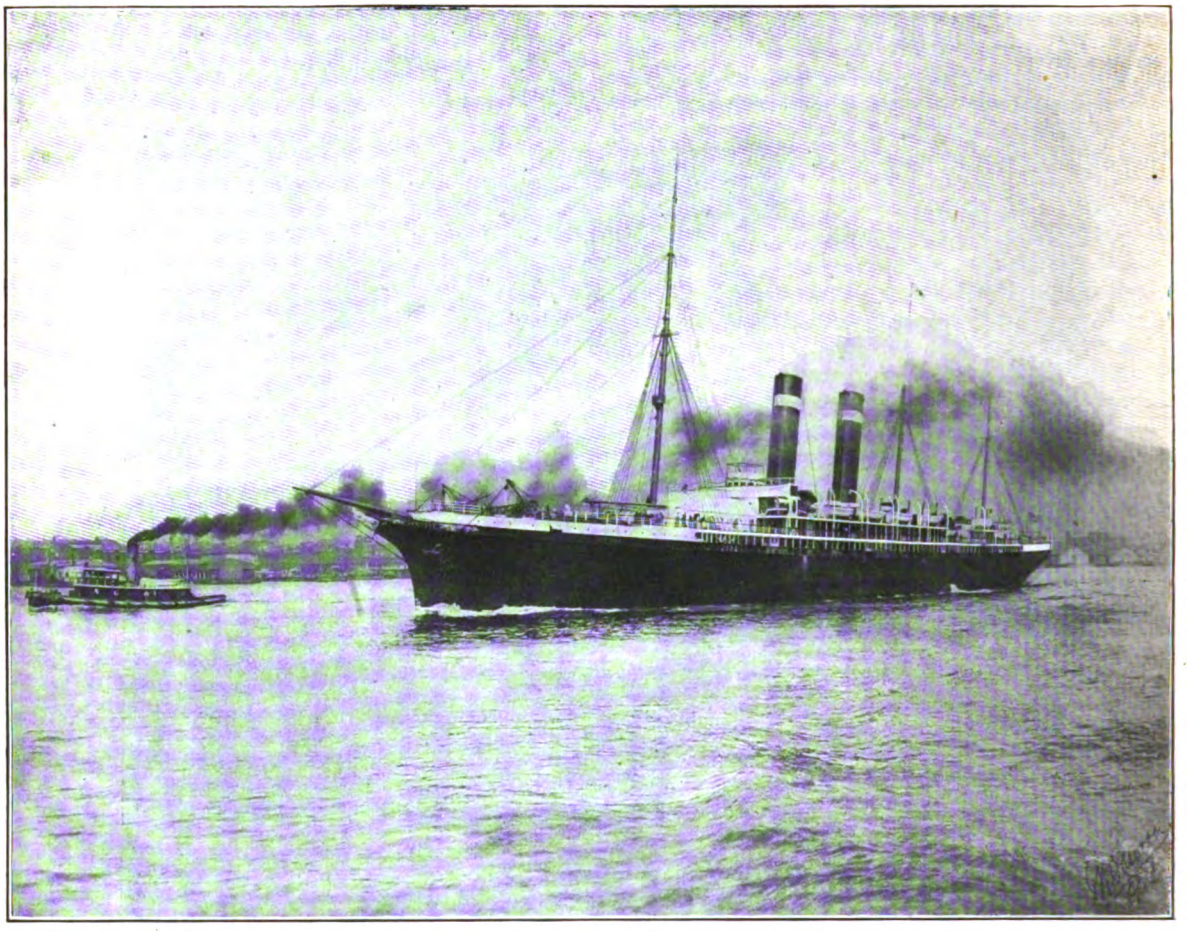

THE RECONSTRUCTED AMERICAN LINE STEAMSHIP NEW YORK.

THE RECONSTRUCTED NEW YORK.

After nearly two years of absence from the Atlantic ferry the American liner *New York,* of the International Mercantile Marine Company, has now resumed her service on the United States mail line from New York to Southampton. It was on May 28, 1901, that the *New York* left her North River pier for the Cramp shipyard in Philadelphia to receive the thorough remodeling and renovation on which her owners had decided. Since the *New York* was first placed in commission, in 1888, she has won a fine reputation as a fast and comfortable passenger ship. The most brilliant page in her history, however, was her service as a merchant cruiser in the Spanish war, when, in the charge of Captain Charles S. Cotton, U. S. N., now Rear Admiral, with Captain F. M. Passow, who is again in the *New York,* as her commander, this steamer actually did more "scouting" and steamed over more miles of blue Atlantic than any of our cruisers regularly built for war.

In the spring of 1901 the International Navigation Company, now merged in the greater International Mercantile Marine Company, which owned the *New York,* decided to bring this favorite ship right up to the latest advances in marine engineering and naval architecture. The work was to be far-reaching and permanent.

At the Cramp shipyard the outfit of the vessel, including the passenger fittings, boats, and gear, was sent ashore. Then the workmen removed the funnels, uptakes, steam pipes, main boilers, main and auxiliary engines, dynamos, and ventilating and forced-draft fans. When this had been done and everything possible had been landed, the great ship was lightened so that she had a mean draft of only 16 feet of water. In this condition the *New York* was towed, on August 31, 1901, to the Erie Basin dry-dock in Brooklyn, for there was no dock large enough to receive her on the Delaware. The *New York* entered the dock at Brooklyn on September 25, 1901. There careful preparations had been made to receive her. The keel blocks were raised so as to give more than the usual height between the ship and the dock bottom and to enable the workmen to get easily at every underbody part of the vessel.

Now the task of removing the old propellers, propeller brackets, shafting, and rudder was begun, while the ship was made ready, by a complete system of bilge blocks and bilge and side shores, for the alteration of her stern and for the reconstruction necessary on account of the new boiler and engine arrangements.

It had been decided not only to give the *New York* complete new boilers and new engines of the latest

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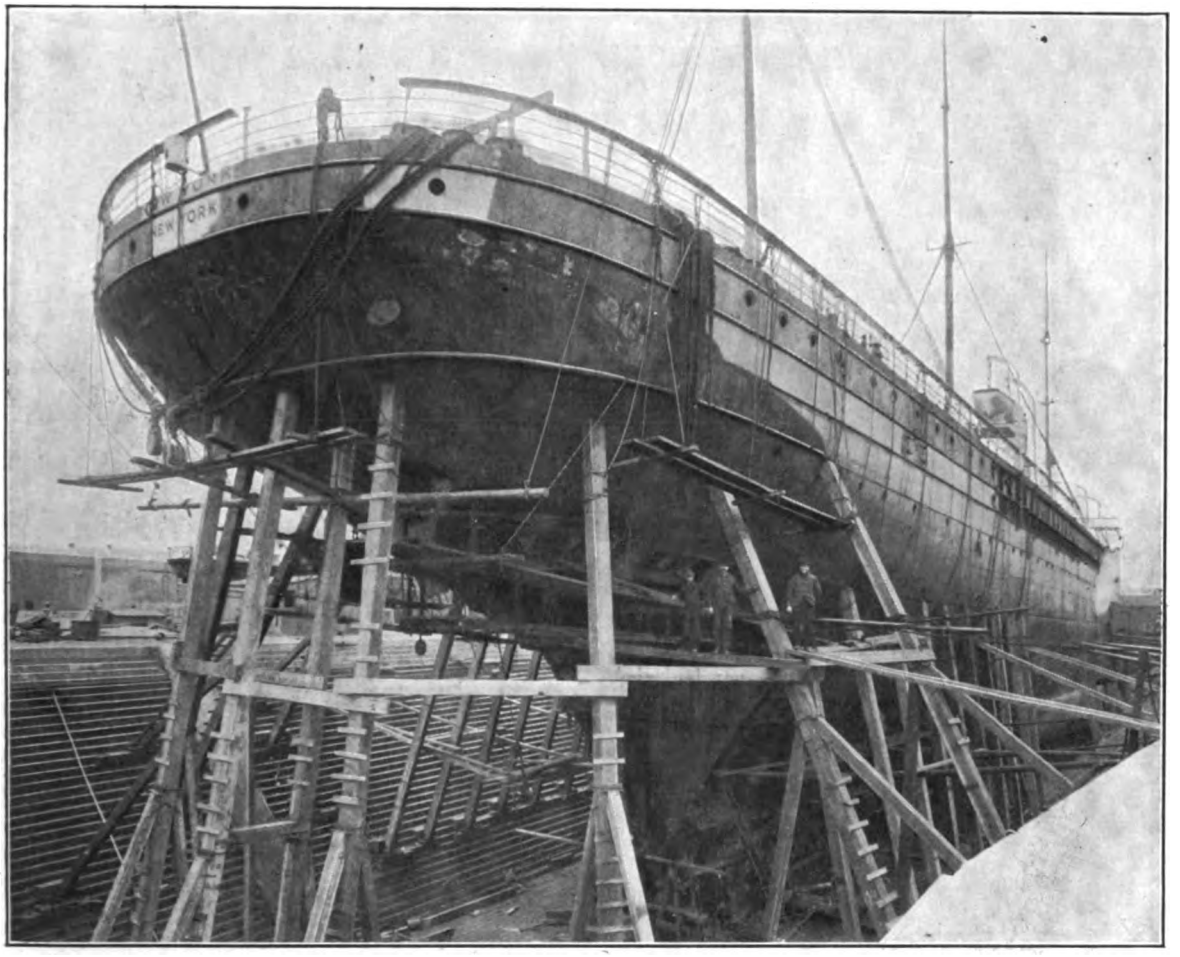

CUTTING AWAY THE STERN OF THE NEW YORK IN ERIE BASIN DRY-DOCK.

type, but also to reconstruct the whole after end of the ship according to the modern practice of enclosing the propeller shafts within the hull. The new plan, which is now being generally adopted, gives ready access to every part of the shafting between the engine and the tail-shaft stern gland, protects the shafting, and eliminates the resistance due to the propeller brackets. In this reconstruction the rudder and steering gear were to be included.

This radical alteration involved the cutting away of about 150 feet of the ship forward of the stern post. It was a difficult undertaking, because of the massiveness and rigid riveting of the hull, and even more difficult was the removal of the engine foundations and the double bottom. At the same time the bulkheads in the machinery space and bunker casings were also cut away and the shaft tunnels were extended, and all the butt straps of the shell plating were replaced. These separate parts of the scheme of alteration and reconstruction were carried on simultaneously.

A brief outline of the method of reshaping the after end of the ship may be interesting. The Messrs. Cramp laid off on their mold loft floor the form of the after body of the ship as she was built, and faired in with this the new form of stern, laid down from plans supplied by the *New York's* owners. The extent of the necessary alterations to the ship was then determined and the material ordered; the molds for the new work were made and shipped to the Erie Basin, where the material was to be delivered. While the after body was being cut away for reconstruction, the new frames were bent, bulkhead and floor plates prepared at the Erie Basin, and the new steel castings for the stern frame and rudder were made. When all was in readiness, the frames were erected, faired up in the usual manner, and stringers run and plating laid. At the same time the boiler and engine compartments were being remodeled, the double bottom was reconstructed, the new engine foundation built, and the shaft tunnels were extended to the new stern tubes. When all this work was completed at Erie Basin, the ship was towed back to the Cramp yard at Philadelphia, where new boilers and engines, built at that yard, were put in place on board.

The new arrangement of boilers provides for two instead of three funnels, as formerly, the two new ones being about the size of those on the *Philadelphia*. The space vacated by the middle funnel has been added to the first-class accommodations, where important changes have been made.

The *New York* was the first ship to be provided with

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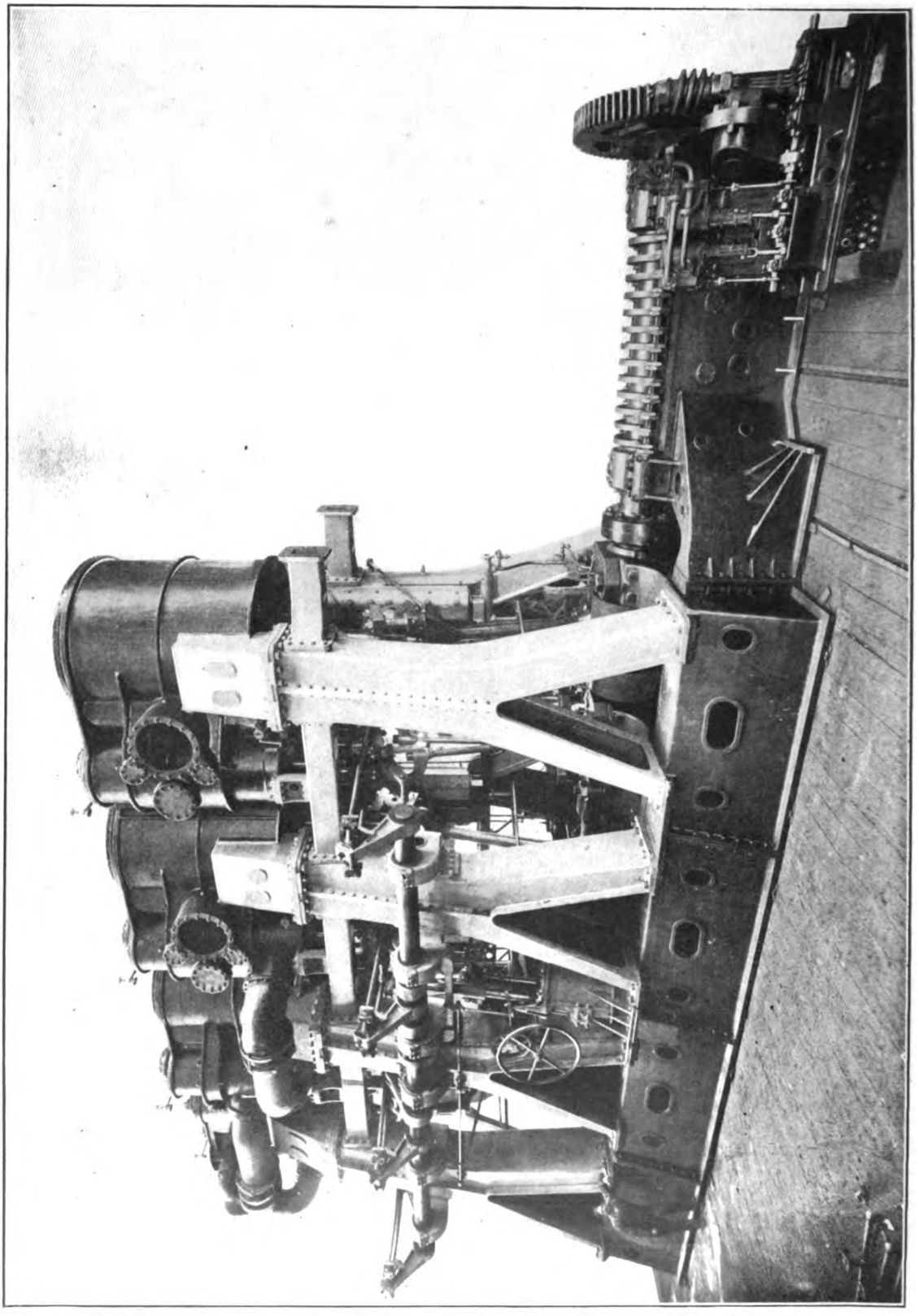

ONE OF THE TWIN-SCREW, FOUR-CYLINDER, TRIPLE-EXPANSION ENGINES, BUILT BY THE WILLIAM CRAMP AND SONS SHIP AND ENGINE BUILDING COMPANY, FOR THE STEAMSHIP NEW YORK.

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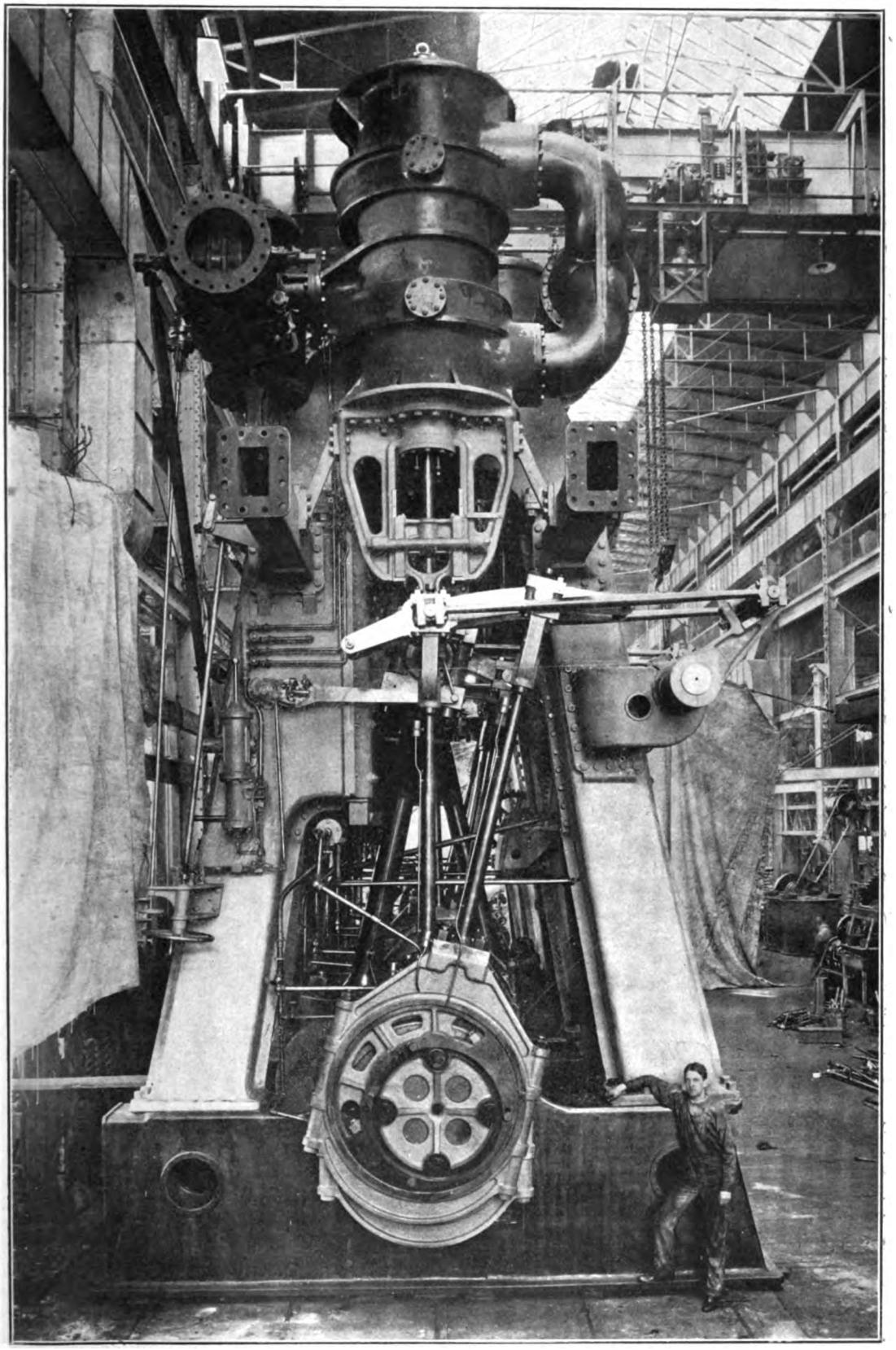

FORWARD END VIEW OF TRIPLE-EXPANSION ENGINE FOR THE NEW YORK ON THE ERECTION FLOOR OF MESSRS. CRAMP'S MACHINE SHOP.

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suites of rooms with private bath rooms, and the success of this new departure was such that it has been carried to a far greater length in the remodeled vessel. She now has many more luxurious private suites. A new, spacious, and handsome smoking room has been constructed in a new deck house abaft the midship saloon entrance on the promenade deck, and is lighted from above by a great skylight of decorated glass. It is divided into alcoves and recesses, and has a stairway to the saloon deck as well as a doorway to the promenade deck, thus making it easily accessible in any weather. Another important change introduced by Mr. J. V. Paterson, naval architect for the company, is the enlargement of the promenade deck, with a view of obtaining wider space for passengers. The result is one of the handsomest and most generous promenade decks in the service. Moreover, the boat deck has been extended over the promenade deck, providing increased shelter for the passengers in rainy weather. The main companionway has been enlarged, and the main dining room, always one of the largest and most beautiful afloat, has been enlarged and redecorated. Many new deck cabins have been added on the saloon deck, and the first-cabin rooms, and indeed, all the interior apartments of the ship, have been thoroughly redecorated and refurnished. At the same time the number of the first-cabin accommodations has been reduced from 520 to 300, so that these passengers in the new ship will have more space and more luxury than ever. The second-cabin passengers have a new drawing room and a new smoking room, while the dining room has been enlarged and the state rooms refitted. The third-class passengers are provided with a well-equipped dining room of their own, and the steerage accommodations generally have been brought up to the most advanced ideas of caring for this important class of passengers.

A feature of the passenger accommodations of the ships of this line has been the systems of forced and exhaust draft for ventilation. The company was the pioneer in this direction, and the original *New York* was very well ventilated. In rebuilding her this question of ventilation has been given due consideration, and been carried out in a manner which secures an abundant supply of fresh air to all parts of the cabins.

A complete new electrical outfit has been installed, and there are three large units and one small one. The plumbing has been renewed throughout, new windlass and warping machinery has been fitted, and also new steam steering gear with two sets of engines.

The machinery consists of two sets of triple-expansion, four-cylinder, direct-acting engines of total 20,000 horse power, and the cylinders are of the following diameters: 42, 66 1-2, 77, and 77 inches, stroke of all being 60 inches. The bed plates are of cast iron, made in four sections, and the front and back columns are of cast steel, each column made in two pieces, flanged and bolted together. The columns are stayed by horizontal distance pieces, and each pair supports a cylinder and its valve, which are made in one casting. There is one piston valve fitted to the forward end of the high-pressure, and two piston valves on the forward side of each of the other cylinders. The valves are operated by Stephenson double link motion, the reversing shaft being at the front. Crosshead guides are on the back columns and of the slipper type. The crank shaft is built up in four interchangeable sections and is of 21 inches diameter. Each section of shaft has two main bearings, and the water service is provided to guides and main journal boxes, top and bottom. In each engine room is installed an independent Blake twin-beam, single-acting air pump with steam cylinders 14 inches diameter and air cylinder 35 inches diameter, the stroke of both being 21 inches. Over half of the pumps are new and of the Worthington type, the main feed pumps being 16 by 10 by 18 inches, of the vertical duplex type. The new propellers fitted have cast-steel hubs and manganese bronze blades.

There are six double-end and two single-end boilers, the former being 21 feet long, the latter 10 feet 6 inches long; the diameter of all is 15 feet 10 inches. The double-end boilers have eight Fox furnaces, 39 inches mean diameter, and the single-end four of the same dimension. Thus the total number of furnaces is 64, giving a grate surface of 1,144 square feet. The heating surface of all eight boilers is 47,920 square feet. Forced draft is provided by eight Sturtevant fans, driven by single-acting compound engines.

As this article goes to press, the reconstructed *New York* is sailing on her first passage to Southampton, and it is to be expected that her record will rival that of her sister ship, the *Philadelphia*, which has given remarkably regular service since her reconstruction. The *Philadelphia's* voyage for twelve successive passages westward has been 166 hours 46 minutes, and the average for twelve eastern passages 166 hours 21 minutes. Since rebuilt this ship has made twenty-seven eastbound voyages, sailing from New York on Wednesday, and, except the one passage in January, 1902, when she sailed from New York late on account of snow and fog, she has not failed to land her passengers at Southampton the following Wednesday—an enviable record for any transatlantic ship.

The *New York* and the *Philadelphia*, because of their fine, fair lines and graceful clipper bows, are still considered the handsomest of the ships in the North Atlantic service. The general dimensions are: 560 feet in length over all, 525 feet between perpendiculars; 63 feet 4 inches beam; 42 feet deep; gross registered tonnage, 10,674 tons, and a displacement at mean draft of about 16,000 tons.

Bids for New Battleships.—Circulars calling for bids for three 16,000-ton battleships authorized by the last naval appropriation act have been distributed among the shipbuilders by the Navy Department. The general dimensions and features of these ships are similar to the *Connecticut* and class described in Marine Engineering for April, 1903. Other things being equal, those bidders who guarantee the completion of the work in the shortest time will have the preference; the maximum time allowed for completion is forty-two months. Bids will be opened June 3, and to prevent a recurrence of the complications which arose through the cruiser's contracts a

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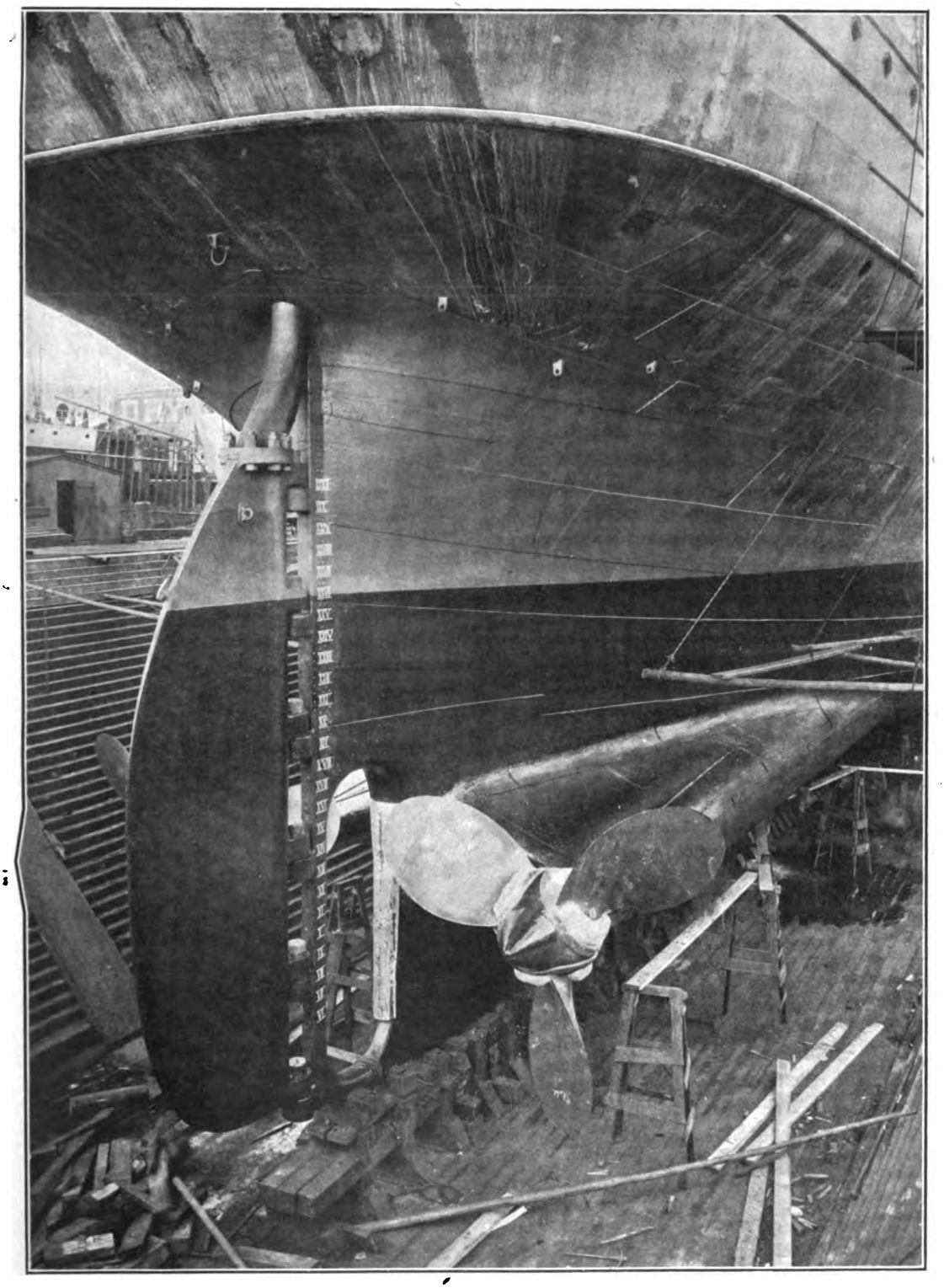
clause is inserted in the circular as follows: "Bidders are hereby notified that after the bids are opened neither the department nor its bureaus will receive from the bidders, nor from any person acting for them, either directly or indirectly, any communication, plan, or explanation, either verbal or in writing, tending to explain or modify their bids in any way whatever, unless requested by the department."



RECONSTRUCTED STERN OF THE AMERICAN LINER NEW YORK.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

THE recent target practice on the *Maine* and the resulting evidences of structural inefficiency in the gun mounts have naturally attracted wide attention from the general public and are exciting the deepest interest on the part of those more directly connected with the naval service. Now that it has all happened it seems relatively easy to explain. The *Maine* and class, as well as all later construction, are armed with the latest type of 50-caliber navy rifle, using smokeless powder and developing 2,800 to 3,000 f. s. velocity. As compared with the earliest types of such guns, developing 2,000 f. s. velocity, this means an increase of energy of over 100 per cent. Compared even with the later preceding types of gun on the *Alabama* and class, or *Kearsarge* and *Kentucky,* the increase is from 40 to 60 per cent. Again, on some of the mounts the length of the recoil cylinder has been slightly reduced, thus reducing the available distance through which the energy can be absorbed, and correspondingly increasing the stress thrown on the structure. Due to these causes in combination, it is not unfair to assume a stress on the structure not less than one and one-half or one and three-quarters times that resulting from the guns used in our previous construction and for which there was available actual experience regarding the sufficiency of gun-mount foundation.

Now, while these various facts were all known and doubtless the possible consequences realized in a general manner, it is undoubtedly true that no one realized the full meaning of this last great stride in modern ordnance. Again, while every one knew that more energy to be absorbed would call for corresponding increase in the weight of structural material employed, perhaps no one realized how near to the margin of sufficiency were the gun foundations used in previous construction. Now that we have before us the results on the *Maine,* it is not difficult to see here and there an intimation that the margin provided in this earlier construction was none too great, and that the present type of gun would require very considerable increase of material in the foundations in order to render them adequate for all requirements. While all of this might have been in a measure foreseen, we do not believe that any one should be blamed because it was not. From the ordnance standpoint the step was enormous, and such steps always cost. Even if the full significance of this step as related to the gun mount had been realized, no one could have told in advance just how much the older type of foundation would need reinforcement in order to render it adequate. Such problems cannot be solved by formulæ nor in any other direct manner. They necessarily depend on experience and only by trial can the final solution be reached. The first trial has been made with the *Maine* and the foundations have been shown to be inadequate. The whole process of the evolution of naval construction is experimental, and this is one of the necessarily experimental steps. No great harm has been done, and some very valuable information has been acquired. In the meantime the foundations on the *Maine* can be adequately strengthened without especial difficulty. It simply means reinforcement, or to some slight extent, perhaps, reconstruction. This can be carried out at no very serious expense, and whatever the amount may be, we may consider it as a fair price for the information thus acquired. For all later construction this information will be available, and where ships are partially or even nearly completed, as in the case of the *Missouri,* immediate steps can and doubtless will be taken to reinforce the gun foundations as indicated desirable from the results observable on the *Maine.*

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WITH the launching and rigging of the *Reliance* and the trials of *Shamrock III.* interest in the coming race grows apace. So far as can now be predicted, both boats are improvements over their predecessors. That the spars on *Shamrock III.* were too light for the enormous spread of sail, was shown by the unfortunate accident just reported, when the mast broke close to the deck and in falling killed one of the crew. So far as can be judged, the model of the new boat is but slightly modified compared with that of her predecessor. Somewhat greater displacement and increased ballast, presumably, provide for longer spars and greater sail area, but in the main the characteristics of the new boat are quite similar to those of the earlier *Shamrocks* and are those which have made of them such dangerous contestants for the *America's* Cup.

There seems to be relatively more difference in model on this side of the water than on the other. The bottom of the new defender is said to be flatter and with modifications both at bow and stern as compared with *Columbia* and *Constitution.* The result of these changes can only be known later when the try-out races are held, but all who have had opportunity for observation agree that she will be a fast boat, presumably best before the wind or moderately free, and with perhaps her weakest point when running close.

From the scientific point of view the most interesting feature of this development of yacht design has been the general regularity with which the designers have been able to turn out something each year a little better than the preceding. This rule has met with occasional apparent exceptions, but has held in the main. Now it is certain that within the limitations which surround the design of a cup defender or challenger, such improvement cannot go on indefinitely. The margin left for improvement must, in fact, be constantly growing more narrow, and we must expect that such improvement as can be made will be by shorter and shorter steps. The history of the last three yachts seems to indicate that we are approaching some such limit, and that further progress will be made with perhaps uncertain steps, and that not every attempt can be counted on as an advance on its predecessor. So long as the present conditions remain unchanged it would seem too much to expect any very marked improvement beyond the present designs. The possibilities within these conditions must, in the nature of things, be very nearly exhausted, and more and more in future years we must expect that the results of races within these conditions will turn on special or accidental features. In the meantime the contest between *Reliance* and *Shamrock III.* bids fair to be fully up to the standard of preceding years, and may the better boat win.

THE condition of the *Maine,* referred to above, is not the only matter in connection with the navy which has awakened anxiety both in and out of the service. The rupture of the gun on the *Iowa,* with its resulting loss of life, is an event far less easy to explain and far more serious in its immediate consequences and in its possible significance. If we mistake not, this is the first gun of the new naval ordnance to burst in such a manner, or even to develop evidence of serious weakness. There have been accidents similar to that on the *Massachusetts* in which the gun was not, at least directly, at fault. Shells have prematurely exploded before, but with no more than local injury to the gun tube. Altogether the accident on the *Iowa* is at present very much of a mystery, and we shall await with great interest the report of the Board of Investigation appointed to examine into the matter. The questions of chief importance are these: Is the result on the *Iowa* chargeable chiefly to the premature explosion of the shell or to weakness in the gun? If the former, can such premature explosion be prevented with a higher degree of assurance than seems now to prevail? If the accident was chargeable to the gun, was the weakness inherent or developed? If inherent, was it due to essential weakness or to initial flaws, and could such have been detected by any possible inspection? If developed, was such weakness or deterioration due to material of indifferent quality at the start, or has the presumably safe number of rounds with modern high-powdered ordnance been placed much too high?

This gun, it is understood, had been fired 125 times, a number well within what was supposed to be a safe life. If the actual life is to be reduced, however, in accordance with the evidence furnished by the *Iowa's* gun, it is most important that such fact should be quickly and clearly established, lest under some unusual strain or accidental circumstance, such as that which occurred on the *Iowa,* other guns now supposed quite safe may unexpectedly fail. By all the laws of ordnance this gun should not have burst as it did. The discovery of the cause and the safeguarding of our modern ordnance from like disaster are certainly duties of the most imperative character.

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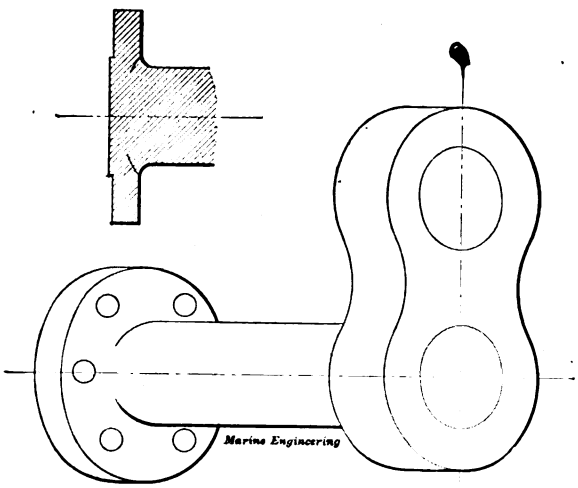
Breakdown on the Steamer Sloterdyk.

On the 12th of February, this year, while the steamer *Sloterdyk* was on a voyage from Rotterdam, Holland, to Newport News, Va., a heavy knocking was heard in the low-pressure cylinder, which shook the engine badly. The engine was immediately stopped, and after a careful inspection it was found that the intermediate-pressure crank shaft was cracked in the fillet of the after coupling flange, as shown in the sketch. The entire engine staff got to work and disconnected the shaft and strapped it until it was ready for removal.

By this time, according to the account, all the engineers were tired out and had to knock off and give place to the deck department. The captain and crew took the spare shaft, being an interchangeable section, from the bulkhead and shoved it in front of the engine. Then they took the old shaft out and put it in the place where the spare shaft had been stored. The next morning the engineers started to work at regular watches. Key seats for the eccentrics had to be cut, and coupling bolts fitted as there were no appliances for reaming the holes. This work was done while a gale of wind was blowing



FRACTURE IN CRANK SHAFT.

from the south, rolling the ship 48 degrees (?) on her sides and drifting her 550 miles to north out of her course. Sails had been set, but were torn into ribbons. Under these circumstances the job lasted eight days and nights, but was satisfactorily completed. When under steam again the ship made 5 miles an hour, her usual speed being 11 miles. When arriving at Newport News she had been thirty-one days on her trip, which she would make ordinarily in about half that time.

She laid up at Newport News Shipbuilding and Dry-Dock Company for repairs. The entire crank shaft was taken out, the coupling flanges of each section trued up separately in the lathe, the coupling holes reamed, and the shaft, all connected, put in the lathe. Then a cut was taken off the journals of about two papers' thickness. The main-bearing boxes were rebabbitted and bored out in place; also the stern-tube liner was refilled with new lignum vitæ. The repairs took fifteen days, working day and night. M. J. H.

Pump Experience.

"Telephone six!"

Dropping my work I went to the 'phone, and, inquiring what was wanted, recognized the voice at the other end as a friend of mine, who asked me if I could go down to a sailing ship lying at North Wharf, as a party there wished to consult with me. This being all the information he could give, I told him I would be there in about an hour.

At the wharf I found a very large sailing ship of foreign build. After looking it over I walked toward the boarding ladder, when I met an acquaintance, a stevedore, who asked me what I was doing there and where I was going. Pointing to the ship, I said I was going on board. Walking rapidly from the edge of the wharf, and beckoning me to follow, we went some distance, when he stopped and said: "Don't go on board that ship; there will be some person killed there directly." This surprised me, and I asked what was the matter, to which he replied: "The pumps on that ship have given out completely. They have had workmen from four machine shops working at them, and about all they have done is to take them apart, put them together, and slop lots of water into them and try to make them go, but no use; and awhile ago the 'Old Man' drove the last crowd ashore, and he is now about as near like a crazy man as can be imagined. So now you know where you are going and about what you may expect if you undertake the job and fail." I told him I guessed I would risk it, and he started on his way, but turned back to ask me to leave any message to my loved ones with him in case I did not return. Telling him I did not anticipate any such trouble, I made my way to the ladder and went on board. I had scarcely touched the deck when I was caught very roughly by the shoulder, and, looking to see who my captor was, found myself in the hands of a stout, much-bewhiskered man, who, before I had time to think much, said in broken English, "You vex bumps?" I told him I came to see or talk of something here, and supposed that was it; on which he dropped his hold on me and started on a run aft, at the same time beckoning me and telling me to "coom." On getting to the part of the ship just forward of the poop, he stopped, and, pointing to something near the port side, said, "There it," at the same time keeping up his motions and gesticulating in a most frantic manner. Going up to where he pointed, I found a pump of the following description:

A block of oak about 16 inches square projected about 3 1-2 feet above deck, the outside of which was used for mooring the ship. The center was bored out and a copper lining inserted, forming the pump barrel, 7 inches diameter and about 7 1-2 feet long, which was joined to a 4-inch suction pipe by a tapered portion. A common plunger with hinge valve in it was used, and the bottom box was fitted with a hinge valve, which was driven tight in tapered part. On the other side of the ship was a similar pump, and these pumps were used to remove bilge water when the ship was under sail pressure and was lying over on either tack. The plunger and lower valve boxes were lying on deck, and a glance at them showed me that the trouble was not there and that I must look elsewhere for it. All this time the captain was following me, constantly asking, "You see

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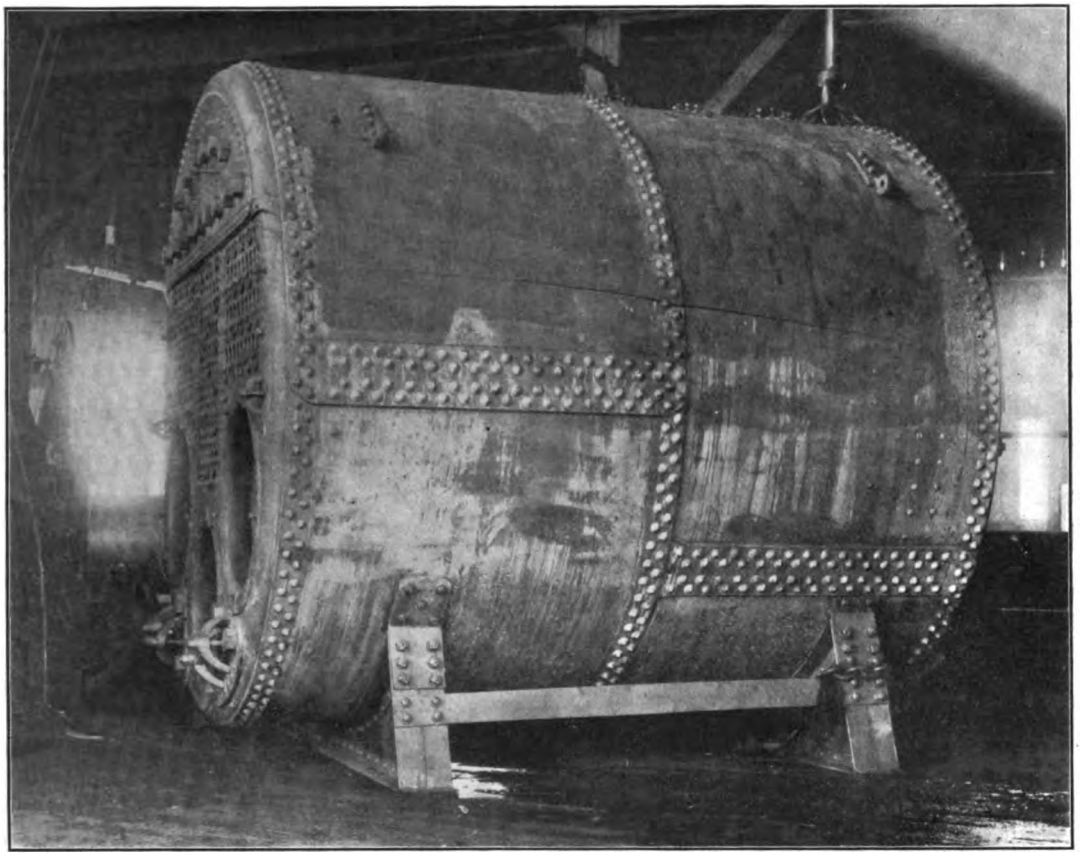
trouble? You vex?" Finally I turned to him and asked him to get me a mirror. "Vot?" he said. I told him a looking-glass, at the same time holding my hand up in front of my face. He was some time trying to understand me, but finally did, and then I thought my time had surely come. Looking at me, and acting as wildly as can be imagined, he said: "You not butty, vot for you vont see you? You vex bumps." I tried to tell him that was what I wanted the mirror for; but it was no use, he would not pay any attention, but went on with his raving at me and the "mirr." Finally another man came on board, and, coming near where we were, told me in very fair English he was the mate, and on my asking him for a mirror he went to his cabin and got one. The sun was shining very brightly, and it happened to be in a good position for me, so, taking the mirror and holding it over the pump barrel, I got a ray of light down a long way into it, sufficiently far and bright enough to show me that the tapered part, where the lower box went in, had parted at the brazing and was causing all the trouble. Going over to the other pump, I found it in the same condittion, so, coming back, I called the captain, and placing the mirror in the right position, I asked him to look in. He did so, and noticed the break as quickly as I had; then, taking the mirror out of my hand, he ran over to the other pump and tried to look into it, but could not get the glass in position. I went over and placed it for him, and, after looking, he turned to me and said, "That do. You go. I get bumps vex now," at the same time motioning me toward the ladder. I told him not to hurry too much, there was something else to fix now; and on his asking, "Vot vex now?" I told him I wanted to be fixed for my time, which required to be done with a ten-dollar bill. He immediately got in his tantrums again, and refused to pay, telling me: "I get bump vex now; you no vex." I made out to him my charge was for knowing and finding out the trouble, and he could do what he liked about fixing them. He finally came to terms, and I left him.

GEORGE H. WARING.



RUPTURED SHELL PLATES OF A SCOTCH BOILER SUBJECTED TO A TEST.

Boiler Ruptured Under Test.

A most interesting photograph has been received from the Polson Iron Works, Toronto, Canada, of a marine boiler which burst in testing. The dimensions of the boiler are as follows: Shell 11 feet 6 inches diameter inside large course, by 13 inches long outside of heads. It contained 192 tubes 3 inches diameter by 10 feet long, and three Morison corrugated furnaces 35 inches inside diameter by 9 feet 11 1-2 inches long. These were of the interchangeable type and led to three separate back connections, with all the flat surfaces stayed to meet the requirements of Lloyd's and the Canadian Inspection Acts for a working pressure of 152 pounds per square inch. It was tested to 228 pounds cold water and was to be operated by induced draft.

After the boiler had been completed and tested at the works up to 300 pounds cold water, the joints in one of the manholes failed, necessitating making another test. After making this joint good, another test was

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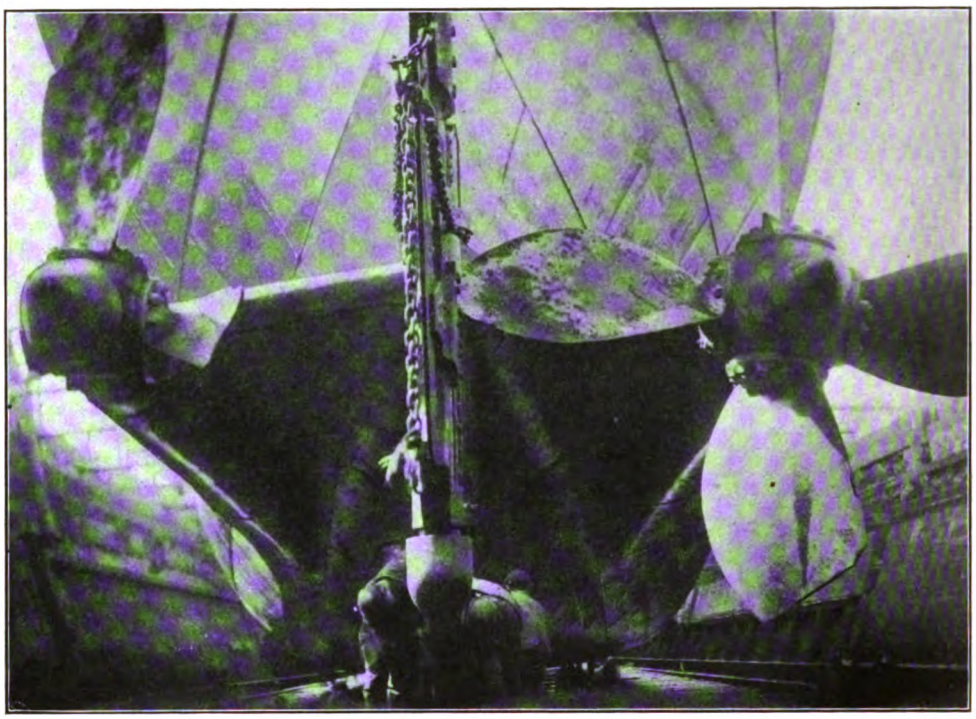
made, when at 270 pounds, without warning, the boiler burst, as can be seen in the photograph. It appears to have started at the circumferential joint and split to both ends, one crack ending at the first rivet in the circumferential seam around the head, and the other ending in one of the staybolt holes around the combustion chamber. The thickness of the plates was 1.023 inches, the longitudinal seams being butted and double strapped and double riveted, with a joint equal to 70 per cent. of the solid plate, and all holes drilled in place. The quality of the steel was best quality flange steel of 60,000 pounds tensile strength, and, as can be seen by the photograph, the boiler burst at what is supposed to be the strongest point, the longitudinal seams showing no signs of weakness or straining of any kind, none of the flat surfaces showing any signs of bulging, nor any of the stays leaking at any point. Two gages were attached at the time of testing, one on the boiler and the other on the hydraulic pump, and both indicated the same pressure, viz., 270 pounds.

After the bursting of this boiler an investigation was held by the Board of Canadian Steamboat Inspectors and also by Lloyd's surveyors. The Canadian Steamboat Inspectors condemned all the shell plates, and the builders were therefore compelled to cut the boiler all to pieces and rebuild it again, getting new plates from the same mill. It then stood the test several times without failure.

Regarding the plates in the boiler that failed, it may be said that, in attempting to straighten these, which was done under an hydraulic press, they broke clean across just as if they were glass, and showing a number of hair cracks inside of the plates at least 3-16 inch deep. These hair cracks were particularly noticeable as the water had worked into them and they were rusted. Attempting to straighten and cold-bend these plates, they failed every time, but when pulled in the testing machine they gave over 60,000 pounds tensile strength. The steel supplied by the same mill to replace the broken plates was noticed in working to be of very much softer character and much more easy to bend, although supposedly all the same quality, viz., flange steel 60,000 pounds tensile strength.

Lloyd's inspectors and the Canadian government inspectors cut all the parts near or adjacent to the fracture and the builders endeavored to obtain from the inspectors a copy of their report on the test. Strange to relate, the inspectors refused to submit the report, stating that they could not give up this test without the permission of the steel company who manufactured the steel.



BROKEN PROPELLER BLADES ON THE STEAMSHIP NECKAR.

Broken Propeller Blades.

Editor Marine Engineering:

Most of your readers probably saw newspaper accounts of the accident to the North German Lloyd steamer *Neckar* about a year ago, and will no doubt be interested in the accompanying photographs, taken by Captain A. Harrassowitz while the steamer was undergoing repairs in dry-dock at Halifax. The *Neckar* encountered one of the worst storms which have swept the North Atlantic in years, and, having lost three blades of her port and one of her starboard propeller, and broken her steam-steering gear and rudder stock, was for nine days all but helpless in the terrific seas. It is thought that the port propeller struck some floating wreckage, breaking three blades, and that one of the blades or part of the wreckage was thrown so as to

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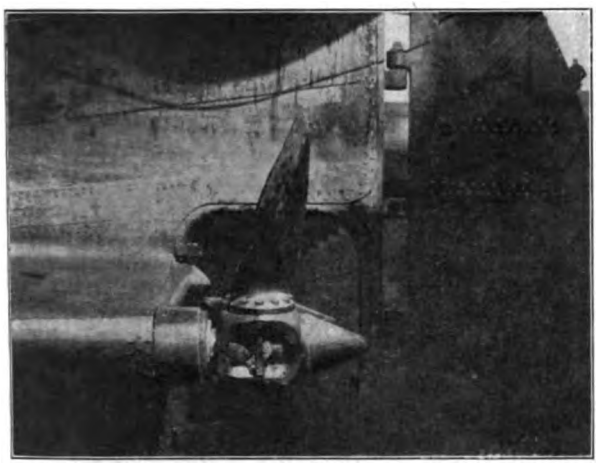
break the rudder stock and one blade of the starboard screw.

It is interesting to note—as shown in one of the photographs—that one of the blades, instead of breaking at the root, as is generally the case, carried away part of the hub.

In spite of her severe injuries and the terrific storms, which continued with unabated force, the *Neckar* proceeded to Halifax under her own steam, being steered by improvised gear, and covering the 700 miles in nine days.



BROKEN CAST-STEEL HUB OF THE NECKAR.

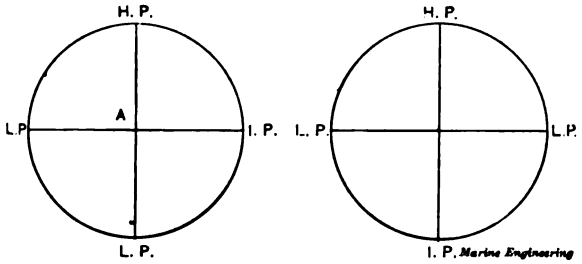
A complete description of the *Neckar* was given in MARINE ENGINEERING in February, 1902, issue.

P. G. L. HILKEN.

QUERIES AND ANSWERS.

Q. 149.—Is there any advantage on a four-cylinder triple by placing the cranks in certain position, as in figures below?

A.—The question of placing the cranks in one arrangement or another, as illustrated, has reference chiefly to the inertia forces and to the general problem of engine balancing. It is impossible, in the general case, to state which of the two would be the better. The final result would depend on the various details of the case and could



not be predicted without a study of all features entering the problem.

The arrangement with the two low-pressure cranks opposite is on the whole more frequently met with than the other, but it might easily result in a special case that the latter method would prove the better of the two. In addition to the influence on the problem of engine balancing, the distribution of the cranks will also influence the smoothness of the crank effort; the latter, however, is of smaller importance than the former.

Space forbids a more detailed discussion of the question, as any attempt to present the matter fully would require a detailed study of the entire problem of inertia forces and engine balancing.

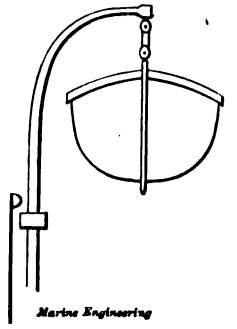
For an excellent discussion of these problems you are referred to a book, recently published, on the "Balancing of Engines," and of which Professor W. E. Dalby is the author.

Q. 148.—Will you kindly advise, through your magazine, the best and most practical formula used in calculating the size and strength of ordinary boat davits, as per sketch? W. E. J.

A.—Let a denote the overhang of the davit in inches.
W " " weight it is to support.
d " " diameter in inches.
K " " safe bending stress.

Then, assuming that the davit is round in cross-section, the principles of mechanics give us the formula:

$$d = 1.366 \sqrt[3]{\frac{Wa}{K}}$$



In using this formula judgment is needed in connection with the selection of a suitable value for the stress K. As the load is often quite variable, the working stress should be taken low to provide for all contingencies. This would indicate for the ordinary davit a value 4,000 to 6,000. Thus, for example, if W, or one-half the boat, equals 1,200 pounds and a equals 3 feet, then with K equaling 5,000 pounds per square inch we have:

$$d = 1.366 \sqrt[3]{\frac{1,200 \times 36}{5,000}} = 1.366 \times 2.05 = 2.8 \text{ ins.}$$

New Steamships Purchased.—The Pacific Mail Steamship Company has purchased from the Atlantic Transport Line the two steamships *Minnelora* and *Minnuahta*, which are now under construction at the New York Shipbuilding Company's yard, Camden, N. J. The ships are not yet off the stocks, but as soon as completed will be placed in the transpacific service. Since these vessels were ordered the Atlantic Transport Line, it will be remembered, has been merged into the International Mercantile Marine Company.

Outboard-Turning Screws.—Screws on the new battleships *Vermont*, *Kansas*, and *Minnesota* will have outboard-turning screws. The naval board of construction has made this change to the former practice in view of observations made in the recent West Indian cruise of our fleets. It was noticed while slightly increased speed was attained on ships with inboard-turning screws, yet the manœuvering qualities were not as good as on ships with outboard-turning screws.

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ENGINEERING SPECIALTIES.

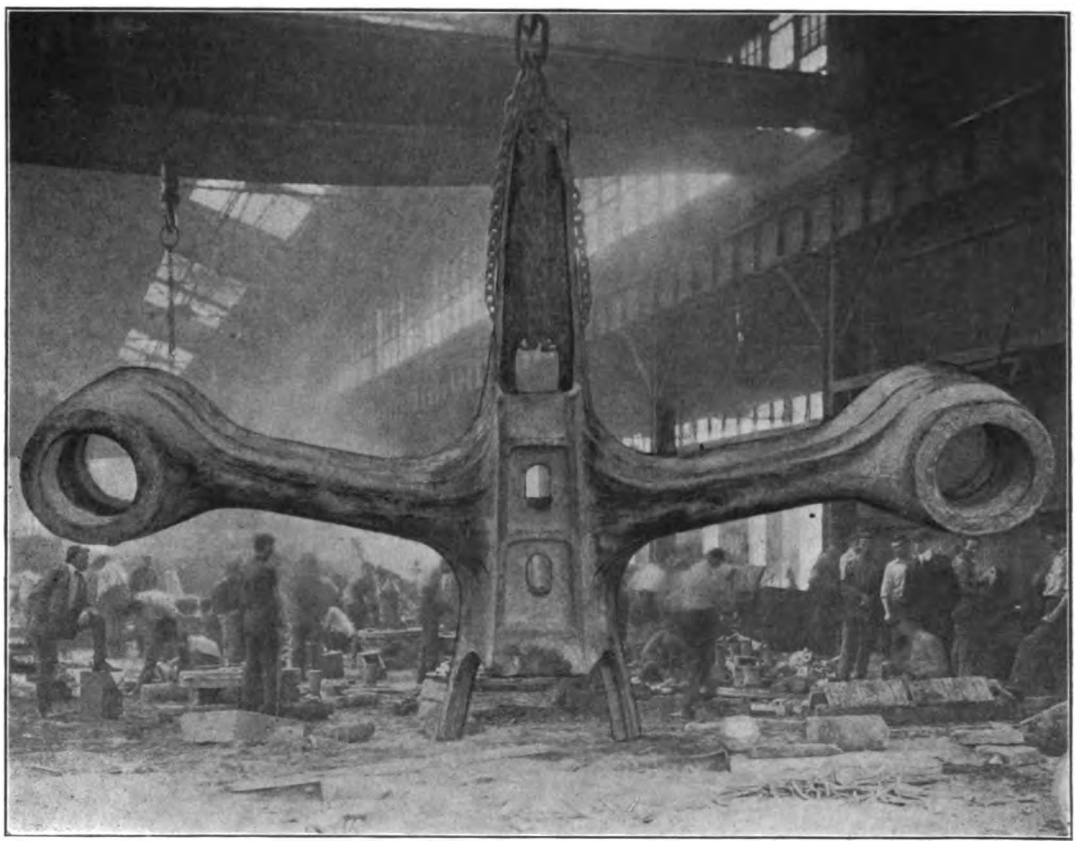
Heavy Steel Castings.

Possibly nothing which entered into the construction of the great Pacific ships building at New London illustrated the development of American manufacturing facilities more aptly than the immense steel castings which were required for the hull construction. All of the hull castings for the two ships were supplied by the Seaboard Steel Casting Company, of Chester, Pa., and in making these immense masses of steel, work of a magnitude was undertaken which had never before been attempted in cast steel.

There were thirteen principal castings for each ship—two pieces for the stem, four for the stern post, the two enormous struts, and five pieces in the rudder and rudder post. The aggregate weight of these castings for each ship is over 150 tons, and yet they were machined to fit up as accurately as though they were the small pieces, by comparison, required in an engine. The rudder and post, as bolted together, were over sixty feet in length, and to make all these enormous castings and fit them together, adjusting the bolts and machining them to line up exactly, was the Seaboard Steel Casting Company's share of the work.

The immense spectacle frame, consisting of a central piece and two struts, weighs alone over fifty tons, and yet these castings and the palms of the struts to the great section of the stern post were fitted up and bolted together so accurately that the deviation was less than would be expected in the struts for a one-hundred-foot yacht. The whole undertaking was most creditably carried out, and has attracted a great deal of attention from marine engineers and mechanics.

Unfortunately, no accurate photographs of these big castings could be secured, but the illustration shows the spectacle frame cast in one piece at the Seaboard foundry for one of the large new ships for the Atlantic Transport Company. It shows the size of this steel casting, which weighed about twenty-five tons finished. These castings are all made from the highest-grade open-hearth steel, subject to Lloyd's specifications and tests, and the metal in them stands the same tests as are required for steel forgings.



CAST-STEEL SPECTACLE FRAME FOR ATLANTIC STEAMSHIP, CAST BY THE SEABOARD STEEL CASTING COMPANY.

Brunswick Compressor Valve.

The valves of the compressors of the Brunswick Refrigerator Company, New Brunswick, N. J., are a radical departure from the old-style conventional types. The suction valve is carried on the inside of the discharge valve and has its seat on the face of the latter. By reason of this construction the suction valve is of a very large diameter, thus preventing excessive lift, while the discharge valve is made the full diameter of the cylinder, virtually becoming a lifting head, so that there need be no clearance. In fact, the piston is set to run a little above the discharge-valve seat. Near the end of the stroke the piston is moving with a very low velocity, being at rest at the point of reversal. By having the piston stand above the valve seat at this point of reversal. the discharge valve is forced by its spring into contact

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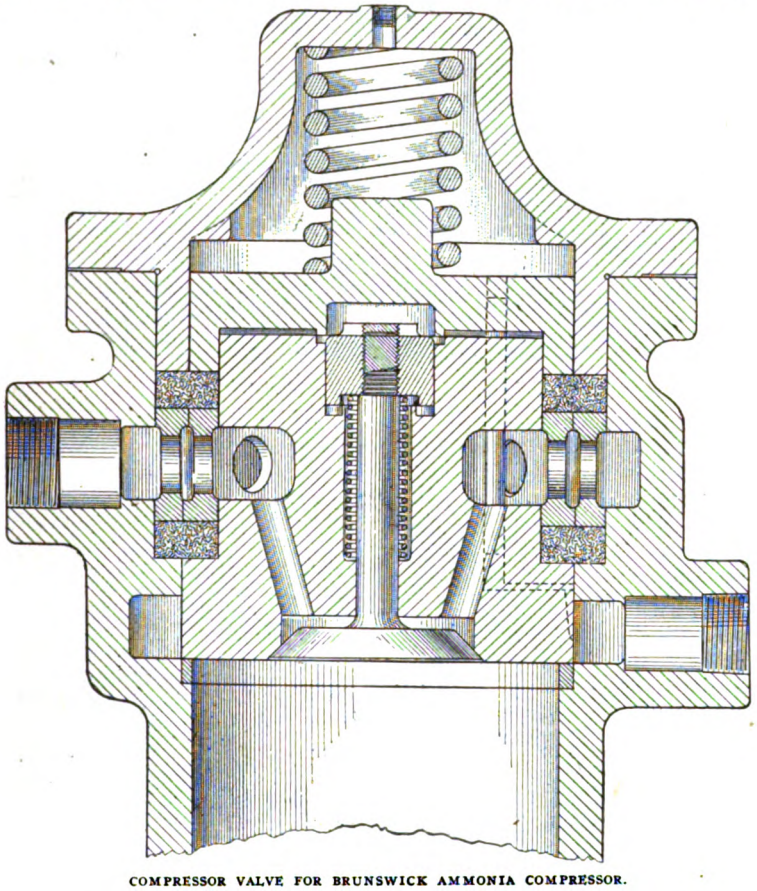
with the piston and is carried by the piston to its seat, thus lessening to a large measure what is known as "the slip of the gas," that is, the rushing of the compressed gas back into the cylinder on the suction stroke before the discharge valve closes. The pressure to which the gas must be compressed before the discharge valve opens, which is a very important point, can be accurately decided upon, so that, with a given width of valve seat and a given condenser pressure, it is simply a question of the ratio of the area of the valve seat to the area of the face of the valve. The greater this ratio, the greater the pressure to open the valve against a given condenser pressure. With a small discharge valve this may be very great, but by making the valve the same diameter of the cylinder this ratio is the smallest possible.

The manner in which the discharge valve is carried in the upper bore of the cylinder involves the principle of the diaphragm. The valve is held suspended in its position by two thick rings of vulcanized rubber, especially compounded to resist the combined action of oil and ammonia. These rubber rings are separated from each other by two spacing rings of cast iron, so made as to allow the suction gas to enter the suction chamber formed around the discharge valve. From this chamber it enters the cylinder through a number of holes drilled in the discharge valve. By use of this diaphragm construction the entire area of the back of the discharge valve is *not* exposed to discharge pressure. There is a small area, formed by a shoulder around the valve, upon which there is suction pressure only, it being protected from the discharge pressure by the rubber packing rings. The discharge-valve spring supplies the pressure to balance and seat the valve—the amount of spring pressure for this depending on the area of the valve thus protected from the discharge pressure. By this arrangement is obtained one of the salient features of the valve, that is, the ability to limit the pressure pumped against without any exterior safety valve.

It sometimes happens that an engineer will start up a machine and neglect to open the valve in the discharge line. Under the circumstances a very few revolutions of the machine will produce a tremendous pressure in the line pipe and cylinders and a corresponding undue strain on the shafts, rods, and pins. With the Brunswick machine such a condition of affairs is quite impossible, for the reasons above stated. Start up a Brunswick machine, connect it with a receiver of any size, and when a given pressure is reached—fixed by the discharge-valve spring—the discharge valves on both cylinders stand open and you simply see-saw the gas from one cylinder to the other, consuming no more power than is necessary to overcome the friction of the machine. Of course, with an ammonia compressor this spring is made of sufficient strength to provide for all possible condenser and suction pressures. A tool-steel ring is forced into the cylinder to form the discharge-valve seat, while the valve itself is cut from a solid bar of machine steel. The materials used are the best and the workmanship first class in every particular.



COMPRESSOR VALVE FOR BRUNSWICK AMMONIA COMPRESSOR.

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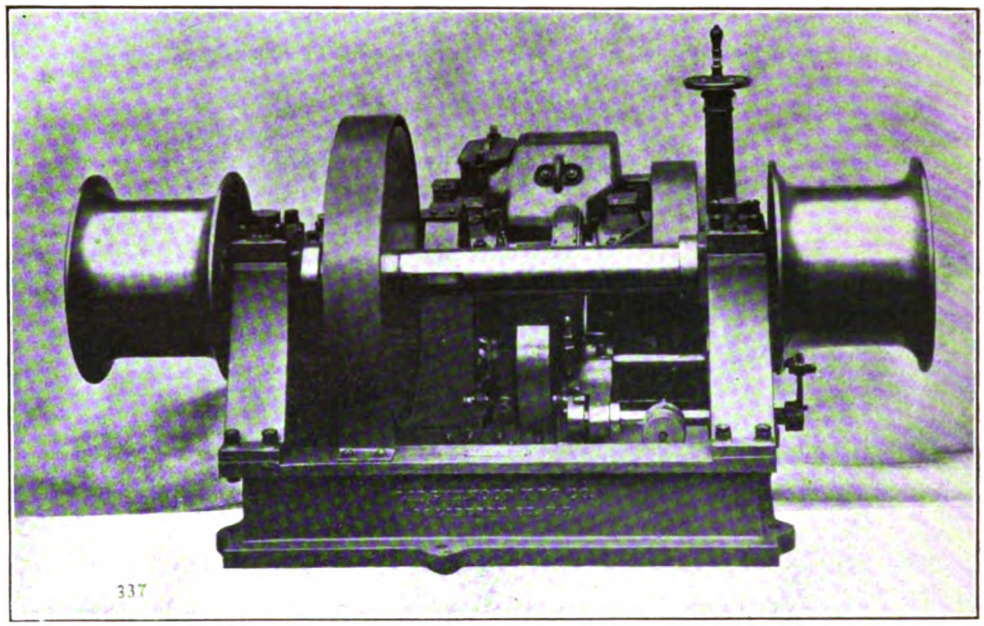
Improved Electric Ship Winch.

The accompanying engraving illustrates the new improved form of ship's winch which has been brought out by the Lidgerwood Manufacturing Company, 96 Liberty street, New York, N. Y., to supply the demand for a modern first-class machine. It is driven by the latest form of armored motor of the General Electric Company, and has all improvements. The controller is of the railroad type, and in the machine shown is located between decks, together with the resistances, while the operating handle is mounted upon a special post containing a contact, etc. The winches are connected by two sets of gearing which give two different speeds, either being thrown in by moving the lever. This is provided with the Lidgerwood thumb latch and detent engaging a ratchet quadrant.



LIDGERWOOD ELECTRIC-DRIVEN SHIP WINCH.

There are in all 76 winches of this style supplied the Eastern Shipbuilding Company for the *Minnesota* and her sister ship the *Dakota*, 52 of them being equipped with 25-horse-power motors with a capacity of 3,000 pounds lift, and the remainder with motors of greater horse power for hoisting heavier weights.

A Launch Whistle.

A whistle seems to be a small item in the equipment of a launch, yet in this there are many points where a good design will overcome the difficulties and annoyances attendant on a whistle of poor design. The whistle here illustrated is one which is blown promptly by pulling the handle of the pump; thus it is independent of an air tank or the engine, and is always ready for use. The pump is of large dimensions, and gives a volume of air sufficient for the blast to be heard a long distance off; in fact, the whistle has been heard for a distance of two miles.

The whistle is made in a four-tone chime, and can be adjusted to a shrill high tone or to a deep low tone, as desired. It is made from best material throughout and guaranteed in every way. The finish is also carefully attended to.

HAND PUMP WHISTLE FOR LAUNCHES.

Many of these whistles have been sent abroad. They are made by the Bowen Manufacturing Company, Auburn, N. Y.

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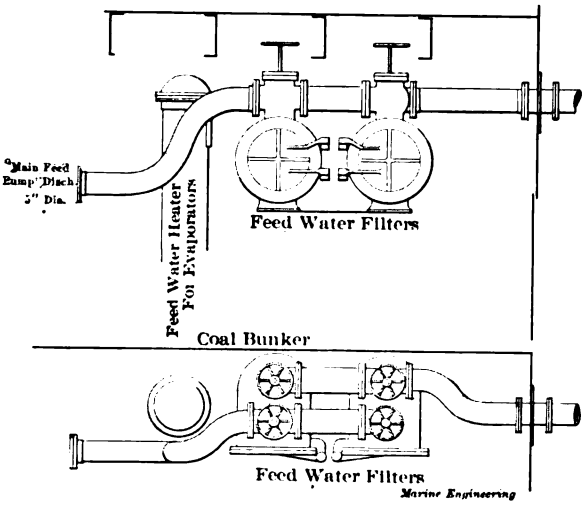
New Feed-Water Filters.

The patent feed-water filters and oil extractors installed on the *Minnesota* and her sister ship, building at New London, Conn., were supplied by the Blackburn



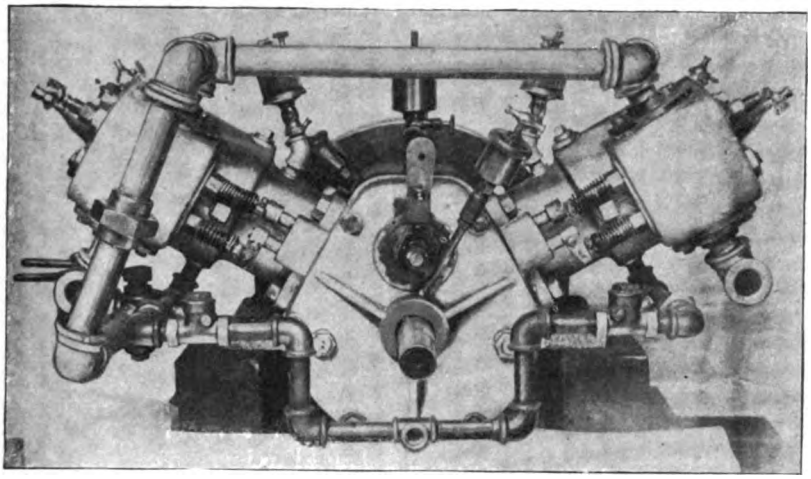
ARRANGEMENT FOR PATENT FEED-WATER FILTERS.

Smith Company, 29 Broadway, New York, N. Y. These filters are of the unit type of chest connected up in parallel, there being two chests to each main feed pump, or four chests in each vessel, one set on the port side and one set on the starboard. Each chest has a filtering arrangement consisting of 19 brass cartridges, perforated with 3-4-inch holes, and having a total filtering capacity per unit of 6,250 I.H.P. The accompanying sketch shows the method of connecting the units, from which it will be seen that either unit can be shut off for removing foul cartridges and replacing with a clean spare set, which is sent with every filter, while the supply of feed water is kept constant and filtered through the second chest. These filters are placed on the discharge side of feed pump, and are accordingly subject to boiler pressure. The filtering medium consists of a stocking of heavy linen "terry" or Turkish toweling, which is drawn over the cartridges and clamped at each end by cartridge plates.

The entire set of filters were tested to a hydrostatic pressure of 650 pounds per square inch. Each unit can be entirely cleaned in 10 minutes. The absolute necessity of preventing oil and grease from entering boilers, especially water-tube boilers, is one of the most important points to be considered in equipping a modern vessel. Not only will oil quickly ruin boilers, but a large increase in fuel is entailed if the boilers are coated with a non-conducting matter such as oil deposit. This is stated to be the largest installation of marine feed-water filters ever built in the United States, aggregating 50,000 I.H.P.

The Burlingame Motor.

The especial features of this gasoline engine are its flat form and control of speed. Its flat form makes it especially adapted to auxiliary yacht use, as it will fit the bilge of a boat and allow of its being placed low, and in most cases under the cockpit floor, out of sight and out of the way, leaving the cabin clear and not filling it with the smell of oil and naphtha. The speed of the engine is under perfect control at all times, and this is accomplished either by the time of sparking or by governing. The time of sparking is regulated by the movement of a lever which projects upward between the cylinders. This lever may be connected to another lever in any part of the boat, so that the person steering may have control of the engine without moving from the wheel. As to governing, any throttle governor may be used. The engine will run steadily at any speed from 200 to over 1,000 revolutions per minute.



COMPACT, LIGHT-WEIGHT GASOLINE ENGINE.

Ignition is by the jump-spark system, and the contact surface being long gives a vibrating spark of long duration, insuring ignition. The contact points are outside of the engine, where they may be reached at any time and cleaned while the engine is running; and if either spark plug needs cleaning, it may be taken out and cleaned without stopping, as the engine will run on either cylinder alone.

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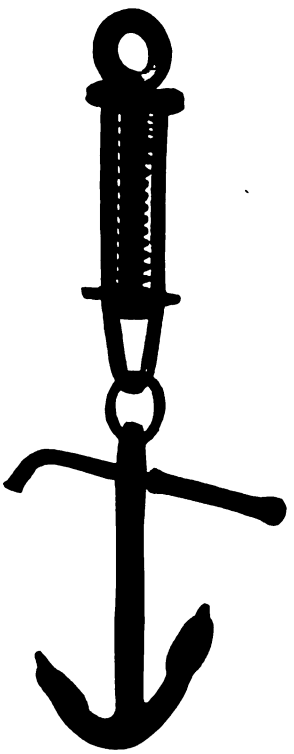
The cylinders being opposed to each other allow the engine to run with almost no vibration, as the explosion on one side is cushioned on the other. The valves are all mechanically actuated, overcoming one fault where the intake valve is operated by suction, as with a suction valve: unless the valve stem is covered air-tight, the wear of the valve-stem guide makes a leak, so that air is taken into the explosion chamber, causing the engine to miss.

Another feature of this engine is the accessibility to the working parts. The cams, gears, etc., are all contained in the crank-case cover, and unscrewing the bolts that connect this to the crank case, and sliding the cover back on the shaft, gives access to all the cam gears, and opens the crank case the full size so that the crank connections may be easily reached. The engine is thoroughly cooled, as the cylinders, cylinder heads, and valve case are all water-jacketed, the water inlet being at the bottom of the cylinder and the outlet from the top of cylinder head. This engine is one of the smallest and lightest engines for marine use on the market, compared with power developed; the dimensions being, total width across both cylinders, 35 inches; from front of flywheel to after side of crank case, 16 inches; height above bed logs, 14 inches; total height from bottom of flywheel to top of piping, 21 inches; and weighs 375 pounds.

This engine, with aluminum crank case for reducing the weight, has proved very successful for automobile use. It is made by S. C. Burlingame and Company, 49 Washington street, Providence, R. I.



ANCHOR SWIVEL.

Swivel for Holding Anchors.

A patent swivel for holding anchors is manufactured by R. S. Davis, Camden, Me., and as here illustrated consists of a large flat swivel with shackle at either end; one shackle is attached to the anchor and the other to the anchor chain. On each side of this swivel are flat pieces of iron, about two inches thick, which are connected at the ends. Through these end pieces the swivel bar runs and is connected to but one crosspiece. A steel spring about one inch in diameter is coiled around the bar between the two end pieces. It is thus seen that the spring acts as a cushion for any strain which may be transmitted to the anchor, as it will contract when the chain is pulled. This device will prevent the chain from fouling and the anchor from dragging when the ship is riding the waves, as no sudden jerks come upon the anchor. The swivel is made in several sizes to withstand from 10 to 90 tons.

LAUNCHES.

Steamboat Asbury Park.—On March 27 the steamer *Asbury Park* was launched at Philadelphia from the yard of Wm. Cramp and Sons' Ship and Engine Building Company. The vessel is for the New York and Sandy Hook service of the Central Railroad of New Jersey, on which the steamers *Monmouth* and *Sandy Hook* now run. The *Asbury Park* is larger than these vessels, being 306 feet long, 61 feet 4 inches beam, and is propelled by high-power, twin-screw, triple-expansion, four-cylinder engines.

Steamer City of South Haven.—The new steel steamer of the Dunkley-Williams Line, built for the South Haven service on Lake Michigan, was recently launched from the Craig Shipbuilding Company's yards, Toledo, Ohio. The general dimensions of the vessel are: Length, 260 feet; beam, 40 feet; depth, molded, 16 feet; draft, light, 12 1-2 feet. The vessel is built of steel throughout and will be double-decked. The machinery consists of triple-expansion engines of 3,000 horse power and six boilers with a working pressure of 225 pounds. There are one hundred state rooms, all of which open outside and are provided with running water and telephone service, the latter connected with the purser's office. Considerable interest has been taken in the naming of this ship, as a rival company is building a vessel for the same service and expected to use the name *City of South Haven.*

Armored Cruiser West Virginia.—On April 18 the armored cruiser *West Virginia* was launched with elaborate ceremonies at Newport News from the yard of the Newport News Shipbuilding and Dry-Dock Company. The keel of the *West Virginia* was laid September 16, 1901, and the contract calls for her completion January 24, 1904. Her length over all is 502 feet; extreme breadth, 69 feet 6 1-2 inches; mean draft, 24 feet 1 inch; displacement, 13,680 tons. She will be driven at a speed of 22 knots by twin-screw, vertical, triple-expansion engines, steam being furnished by Babcock and Wilcox boilers. The main batteries include four 8-inch B. L. R., fourteen 6-inch R. F. guns ; and the secondary battery consists of eighteen 3-inch R. F. G., twelve 3-pounder R. F., and eighteen smaller guns ; the water-line belt of armor varies from 5 to 6 inches; the turrets from 6 to 6 1-2 inches, and the barbettes are of 6-inch armor. A large delegation of West Virginia officials attended the launching. The ship was christened by the daughter of Governor A. B. White.

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PERSONALS.

George Uhler, former president of the Marine Engineers' Beneficial Association, has been appointed Supervising Inspector General by the Secretary of the Treasury, L. M. Shaw, in place of James A. Dumont, resigned.

Frank A. Jones has been appointed National President of the Marine Engineers' Beneficial Association.

Samuel Shaver and J. P. Burg have been appointed Corresponding Secretaries 41 and 78, respectively, of the Marine Engineers' Beneficial Association.

John Gardner, formerly with the Wm. R. Trigg Company, Richmond, Va., has accepted a position with the Morgan Iron Works, foot of East Ninth street, New York, N. Y.

C. M. Andrews, who formerly held a position as draftsman with the Wm. R. Trigg Company, Richmond, Va., has taken a position in the drafting room of the New York Shipbuilding Company, Camden, N. J.

Alfred H. Knight, who was hull draftsman in the New York Shipbuilding Company, Camden, N. J., has taken a corresponding position in the Great Lakes Engineering Works, Detroit, Mich.

George Howard Paul, who was second assistant engineer in the United States Revenue Cutter Service, is now acting warrant machinist in the United States Navy, serving on U. S. S. *Kearsarge*.

J. Henry Stannard, formerly engine draftsman of the Wm. R. Trigg Company, Richmond, Va., is now an engine draftsman in the New York Shipbuilding Company, Camden, N. J.

William Knapp Hathaway has gone with the New York Shipbuilding Company as draftsman. His former position was as draftsman with the American Pipe Manufacturing Company, Philadelphia, Pa.

M. J. Hekking, who was formerly in the engine-drafting room of the Wm. R. Trigg Company, Richmond, Va., is now with the Newport News Shipbuilding and Dry-Dock Company, Newport News, Va.

Walter Wythe Young, formerly marine engine draftsman with the Midvale Steel Company, Nicetown, Pa., has gone to the New York Shipbuilding Company, Camden, N. J., where he has accepted a position as draftsman in the engine department.

Olaf P. F. Briggs, who held a position as draftsman with the Anchor Engine and Machine Company, Pittsburg, Pa., has taken a position in the drafting rooms of the New York Shipbuilding Company, Camden, N. J.

Charles S. Philips, who was formerly engine draftsman with the Perth Amboy Shipbuilding and Engineering Company, Perth Amboy, N. J., has accepted a position with the Blackburn Smith Company, 29 Broadway, New York, N. Y., as engine draftsman.

Arthur P. Allen, designer and supervising engineering draftsman with Moran Brothers Company, is now senior partner of the firm of Allen and Ballord, naval architects and marine engineers, 104 New York Block, Seattle, Wash.

G. M. Kohler, assistant to consulting engineer of the Columbia Iron Works, St. Clair, Mich., has taken a position as assistant to the chief engineer of the U. S. Revenue Cutter Service, Washington, D. C.

Ethelbert Belknap Morril, who was formerly a mechanical draftsman with the B. F. Sturtevant Company, Boston, Mass., has gone to the New York Shipbuilding Company, Camden, N. J., where he has taken a position as mechanical draftsman.

Ralph Entriken has left the drafting room of the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., to accept a position as draftsman with the New York Shipbuilding Company, Camden, N. J.

Ernst G. Ekstrom, formerly marine engine draftsman with the Newport News Shipbuilding and Dry-Dock Company, Newport News, Va., has taken a position as draftsman in the engine department of the New York Shipbuilding Company, Camden, N. J.

Carl J. Roelker has left Wm. R. Trigg Company, where he was employed as a mechanical draftsman, and taken a corresponding position with the New York Shipbuilding Company, Camden, N. J.

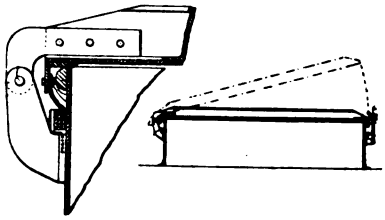
F. Carl Kohler, who was formerly a draftsman of Morse, Williams and Company, Philadelphia, Pa., has taken a position as draftsman with the New York Shipbuilding Company, Camden, N. J.

William A. Ridout has gone with the New York Shipbuilding Company, Camden, N. J., as draftsman. His former position was as engine draftsman with the Wm. R. Trigg Company, Richmond, Va.

Battleship Connecticut.—On March 10 the first keel plate of the battleship *Connecticut* was placed in position in the Brooklyn Navy Yard, and the race between government and private warship construction was begun. A few days later a labor agitator intimidated the men of a private concern who were erecting a crane to be used in constructing the battleship, and the men quit work. This matter has been taken up at Washington and the government has now provided a steamboat on which the men engaged in work on the crane will be taken care of, and a corps of marines will protect the workmen from any interference.

SELECTED MARINE PATENTS.

722,215. COVER FOR VESSELS' HATCHWAYS. EDWIN W. DERUSETT, TYNEMOUTH, ENGLAND.



Claim.—1. The improvements in and relating to covers for vessels' hatchways and similar openings, comprising the combination of a hatchway, a cover thereto, a flexible waterproof strip having one of its edges attached to the edge of the cover, and means for clamping said waterproof strip tightly in a position overlapping the joining edges of the cover and hatchway.

2. The improvements in and relating to covers for vessels' hatchways and similar openings, comprising the combination of a hatchway, a cover thereto, a flexible waterproof strip, means for permanently fixing one edge of the said waterproof strip around the edge of the hatchway cover, and means for detachably clamping the other edge of said waterproof strip to the hatchway framing so that said strip overlaps the joining edges of the cover and hatchway. Seven claims.

722,436. TRUCK FOR TRANSPORT OF SHIPS, ETC. CARL V. SUPPAN, VIENNA, AND BELA SZENDI, BUDAPEST, AUSTRIA-HUNGARY.

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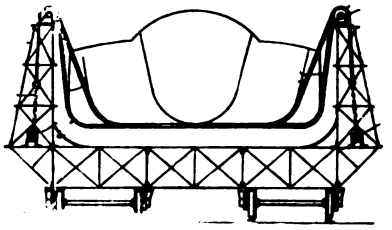
Claim.—1. A vehicle for transporting vessels provided with a suitable body or superstructure, in combination with a cradle



in which a vessel is held in suspension in said superstructure, and composed of flexible bands adapted to automatically adjust themselves to the cross-sectional outline of such vessel. Three claims.

722,516. AIR SHIP. EDWARD P. JOHNSTON, HIGHLANDS, COLO. Fourteen claims.

722,572. SCREW PROPELLER. JOHN A. FEHLMAN, CROWNPOINT, IND.

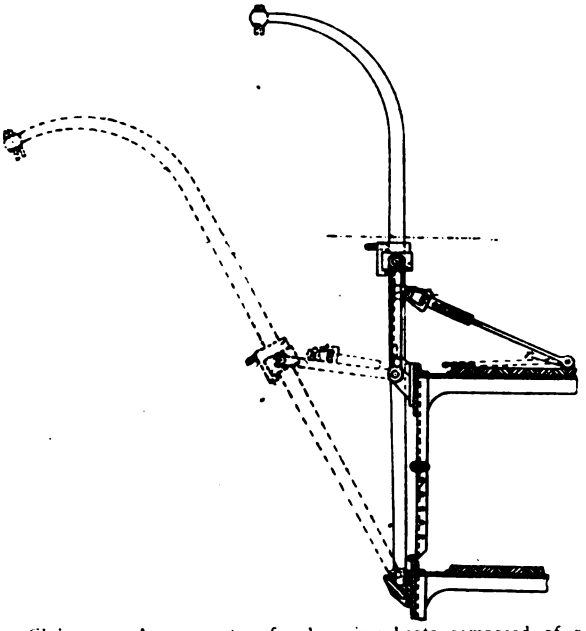
Claim.—In a screw propeller, in combination, a buoyant cylindrical body or shaft having conical heads, a longitudinally-concaved blade extending spirally around the shaft and making a plurality of turns between its ends, a tapered journal cap secured to each of the heads, a brace located in the cylindrical shaft near each end, a shaft entering into and secured in the journal cap and the brace, and journal bearings adapted to be secured to the hull of a vessel to receive the journal caps. One claim.

723,131. APPARATUS FOR REMOVING BARS AND SHOALS. EDSON BRACE, ST. LOUIS, MO.

Claim.—1. A device for dredging channels, comprising a frame, an engine mounted upon said frame, shafts carried at the ends of said frame, sprocket wheels slidably mounted upon said shafts, dredging chains operated by said sprocket wheels, said engine operating the device, and means for anchoring the device. Three claims.

723,333. BOAT-PROPELLING MECHANISM. JOSEPH M. STORY, OWOSSO, MICH. Two claims.

723,416. BOAT-LOWERING APPARATUS. ERNST O. SPETMANN, HAMBURG, GERMANY.



Claim.—1. An apparatus for lowering boats composed of a pivoted and axially-rotatable davit, a slide mounted on the same, and a pivoted arm connected to the slide. Two claims.

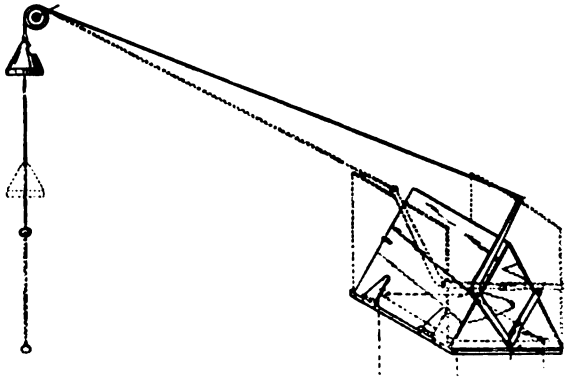
723,647. BUOYANT SEAT OR COUCH. HORACE S. CARLEY, HYDEPARK, MASS.

Claim.—1. A seat or couch consisting of a lifeboat having a continuous float of annular or similar form, a frame removably resting upon said float, and a pad or cushion resting upon said frame. Eight claims.

723,793. MEANS FOR OPERATING HATCHWAY DOORS. WM. R. WILCOX, SARATOGA, WYO.

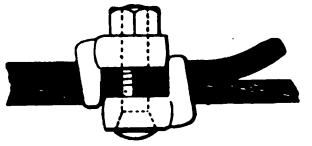
Claim.—1. In means for operating hatchway doors, the combination of a lever fulcrumed on one of the doors and having a downwardly-extending arm forming a toggle member, a link pivoted at one extremity to the opposite door, the opposite extremity of the link being pivoted to the downwardly-extending lever arm forming a toggle joint, and means connected with the free arm of the lever for manipulating the devices to open and close the doors.

2. In means for operating doors of the class described, the combination of a lever fulcrumed on one door, a link connected with the other door at one extremity and with one arm of the lever at the opposite extremity, and means connected with the other arm of the lever for opening the doors, said means comprising a flexible device, a guide over which said device passes, a counterweight connected with the opposite extremity of



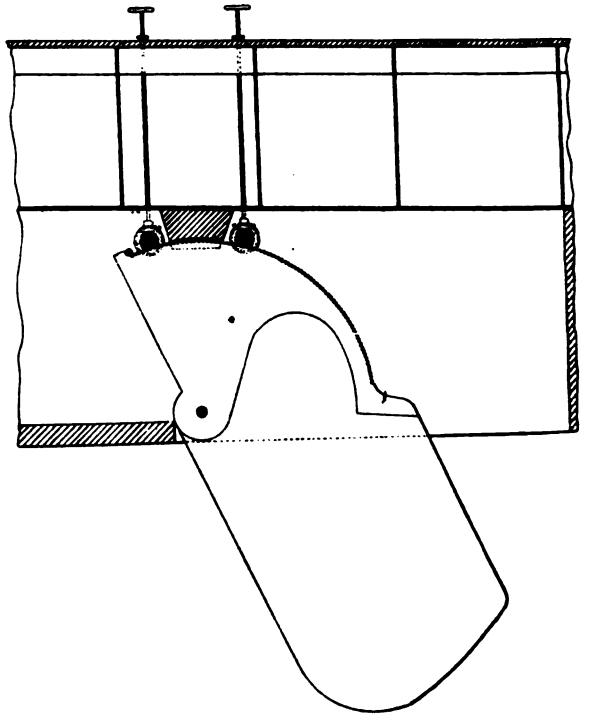
the flexible device, and a depending rigid device connected with the counterweight. Four claims.

723,862. GUY CLAMP. THOMAS E. HALLETT, CHICAGO, ILL.



Claim.—1. A clamp, comprising a pair of plates, each having at one end a pair of ears, the ears upon one plate extending longitudinally of those upon the other, each plate having a groove located between the ears and extending longitudinally of the plate, the said ears upon each plate being of such a length that when the clamp is assembled they will be opposite the ends of the companion plate, in combination with means for clamping the plates together. Four claims.

724,217. CENTERBOARD. ANSON P. STOKES, NEW YORK, N. Y.



Claim.—1. The combination with a centerboard of one or more strengthening-pieces secured on the same at its pivoted end, whereby the centerboard is to some extent balanced and a strong connection afforded with the shaft on which the same is mounted.

3. The combination with a centerboard, of a segmental rack on the pivoted or forward end, one or more pinions meshing with said rack, gearing for causing said pinions to rotate and means for actuating said gearing whereby the centerboard may be raised or lowered. Seven claims.

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Marine Engineering

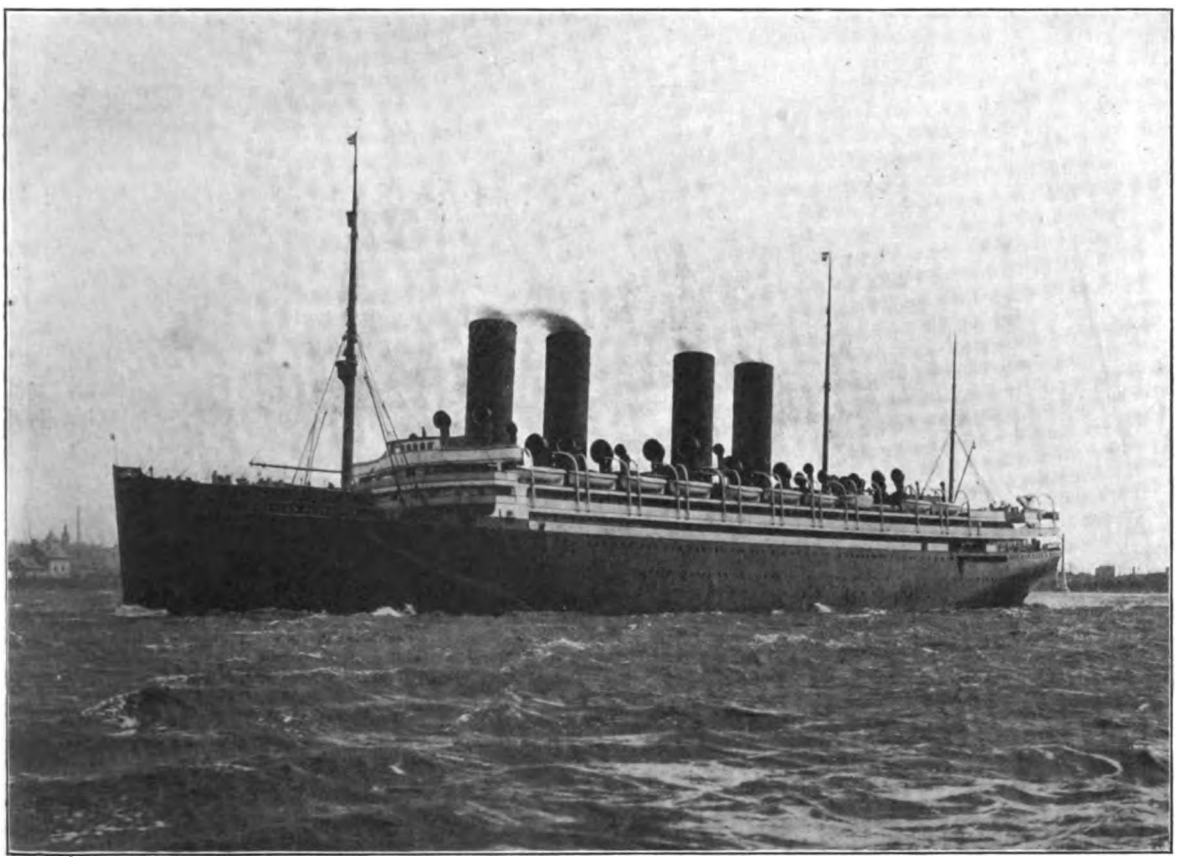
Vol. 8. NEW YORK, JUNE, 1903. No. 6.

NEW NORTH GERMAN LLOYD EXPRESS STEAMSHIP KAISER WILHELM II.

The magnificent new ship *Kaiser Wilhelm II.*, of the North German Lloyd Steamship Company, has made her first appearance in New York harbor, and has created much interest because of her immense size and exceedingly elaborate passenger accommodations.

Evidently the builders have not in any way been limited as to the cost of the ship, for she is the most thoroughly and expensively fitted out vessel to be seen in the passenger service. This is in evidence from stem to stern. In general appearance she resembles the *Deutschland* and the *Kronprinz Wilhelm*, the most recent big ships up to date built in the German yards. It was the intention of the owners to secure in this new ship a vessel of very great speed, by which she was to snatch the record from the *Deutschland*, of the Hamburg-American Line, and, at the same time, to have a vessel that was the most elaborately equipped in the world.

Following these lines, one would not expect to see much space devoted to carrying cargo; in fact, there are but two cargo hatches, one forward and one aft, at the break of the deck houses. Under the forecastle deck is placed a vertical engine for operating three capstan hoists driven by gearing and shafting to the forecastle deck. The windlass engine is on the deck below and drives two vertical drums round which the chain is passed. The ventilators in this exposed part of the ship have welded steel plate hoods which are of the same size as the body of the ventilator and have cast-iron covers.



NEW EXPRESS STEAMSHIP KAISER WILHELM II. LEAVING BREMERHAVEN.

The lay-out of the first-class passenger accommodations is most extensive, and the numerous passages, decks, and saloons are quite confusing. The names of the seven decks of the ship are as follows: Orlop, lower, main, upper, spar, promenade, and upper promenade. The ship can accommodate 775 first-class passengers, 343 second-class, and 770 third-class passengers. Add-

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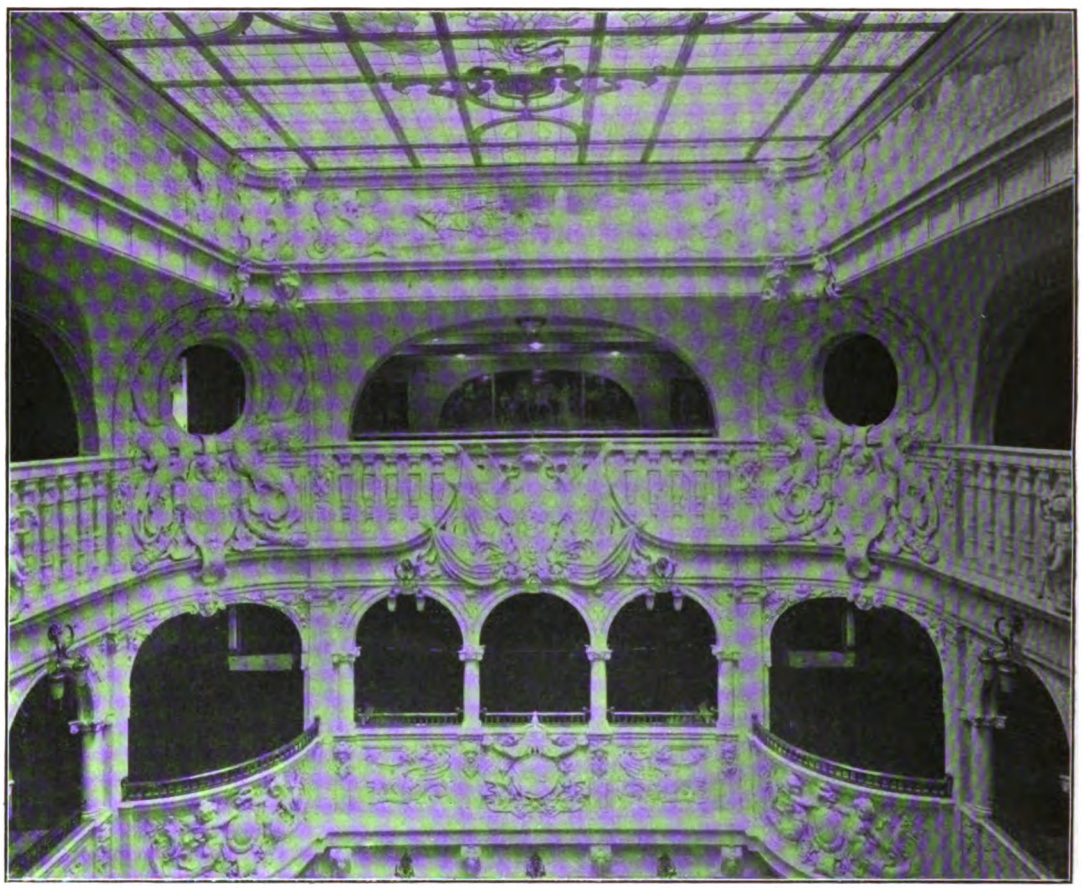
ing to this the complement of a crew of 600 men, including officers, the total number to be cared for will be about 2,500. Included in the first-class cabins are two so-called Imperial suites, 8 apartments de luxe, and 12 state cabins. In addition there are 290 cabins for the first-class passengers and 107 for the second-class. On the upper-promenade deck, at the forward end of the house, is a very beautiful writing room or library, furnished in red draperies, the panels and wainscoting being decorated with fine lacquer work. On either side of the ship, aft of this, are the Imperial suites, comprising bed rooms, parlor, breakfast room, and bath, fitted up in a most luxurious and elegant manner. Each suite is decorated in colors of its own and has electric heaters, folding beds, brass bedsteads, or lounges. The woodwork throughout is a very fine finish, some suites being in mahogany, others in maple, oak, etc. The panels are chiefly of silk tapestry. Clothes presses are built in each room. The private bath rooms are all large-sized rooms and many of them are equipped with tinned tubs. The very latest sanitary plumbing is installed throughout.

Forward of the main stairway and vestibule is the drawing room, beautifully decorated and with light silk draperies. The principal feature is a large painting of the German emperor; other paintings decorate the walls. In the center of the room is a beautiful large skylight and below it is the glazed dome to the light well for the dining saloon. From the vestibule on either side of the ship, corridors lead aft, finished in ashwood and grayish blue. Leading off these passages are many suites of well-appointed rooms. The starboard passage opens into the smoking room, richly decorated in the Renaissance style, which to many is the finest piece of work on board the ship. The floor is laid in green and black rubber tiling and the finishings and furniture are of leather embossed in gold and olive. A beautiful dome supplies abundant light through opaque crystal with green trimmings. The wainscoting of the room is polished mahogany, gold trimmed, and is as fine a specimen of carved work as can be seen afloat. Above a large open fireplace is a painting surmounted by a statuette of Germania. The passageway from the after end of the smoking room leads between the engine casing to other state rooms and also to a stairway to the two Vienna cafés, brilliantly lighted rooms finished in yellow, gold, and olive. One is for the use of smokers and the other for non-smokers.



BALCONIES AROUND DINING SALOON LIGHT WELL, STEAMSHIP KAISER WILHELM II.

Descending two flights of stairs we turn to corridors leading to the first cabins, and at the forward end is the main staircase and entrance hall. A very beautiful effect is secured at this point by balconies which open on the four sides of the light well, both on this deck and on the one below. At the forward end of the bal-

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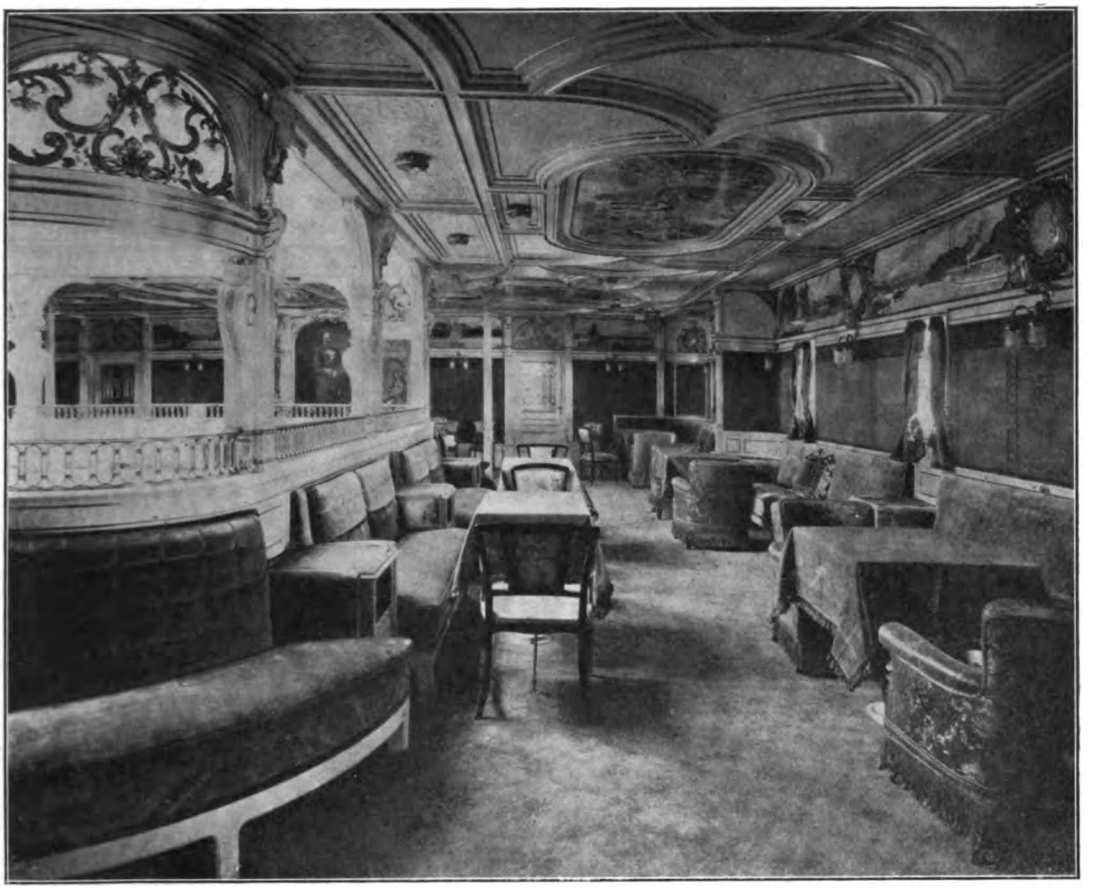
cony is the children's saloon, and directly below it is the purser's headquarters, or, as has been termed on the *Kronprinz Wilhelm*, the "office." Here are the letter boxes for each room, a telephone central station, connections being made to the telephones in all the cabins, a safe for the deposit of passengers' valuables, and, in fact, this is the "bureau of information."

Lavatories, bath rooms, etc., are abundantly provided at suitable points and the equipment is the very highest class of plumbing. The corridors lead forward to other first-cabin accommodations. Descending one more flight we come to the dining room, which is on the main deck and extends from side to side of the ship. Three long tables, fore and aft, will seat about 200 people, and short thwartship tables extend to the sides. The full seating capacity is 554. The decoration is very elegant, although strikingly simple in comparison with German ships of ten and fifteen years ago. It has evidently been the intention of the designer to have the rooms light and airy and in no way oppressive in design. Oil-painted panels of land and marine subjects adorn the walls, and silk tapestry is also used extensively. Because of the large light well, which rises through three decks, and the numerous side lights, this room is well lighted in the daytime, while at night the illumination is no less brilliant by the use of hundreds of electric lights set in the ceilings. This may be considered to be the finest dining saloon of any of the great German ships. The pantries are immediately adjoining the after end of the dining room and a stairway leads to passenger accommodations on the decks below.

The second cabin, placed at the after end of the ship and following the usual plan of the North German Lloyd, is very handsomely finished. There is a ladies' room and a smoking room on promenade deck and large dining saloon on main deck.

Nothing has yet been mentioned of the splendid deck space provided on these ships; on the upper, promenade, and the upper-promenade decks there is a space the entire length of the bridge house, over 500 feet long and about 15 feet broad. On all of these decks the light to the rooms within is admitted through large rectangular ports and a small ventilator above, the type which is generally used on all large passenger ships; the upper ventilator is adjusted by a screw to any position desired.



DRAWING ROOM, STEAMSHIP KAISER WILHELM II.

It is on these decks that one may judge of the fine workmanship of the Stettin yard. The ironwork is a sight which would make envious any superintendent. The riveting, done by pneumatic tools, is a clean piece of work throughout. There are no evidences of expansion joints in the decks or sides of the structure. An after deck house is provided for the second cabin, and a special house aft of this is used for the reserve

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Brown steam steering gear. This gear is attached to the rudder stock, but is only used in case of emergency, the main gear being located below decks and below the water line. Either gear may be operated by telemotors from the bridge or after wheel house. Above the upper-promenade deck, at the forward end, are placed the captain's drawing room and bed room, and above this are the main bridge, a steel chart room, and screen; here are placed the officers' telegraph system, binnacles, steering gear, etc. At this point, also, is the mechanism for operating the water-tight bulkhead doors placed throughout the ship below the water line. This system is the same as that installed on the *Kronprinz Wilhelm*, and is known as the Dörr system, the patents for which have recently been secured by the North German Lloyd Company.

Passing to the engine room one finds an unusual arrangement of machinery; in fact, the *Kaiser Wilhelm II.* is the first merchant ship to be fitted out with four complete sets of engines. There are two four-cylinder, three-crank, quadruple-expansion engines attached to each shaft. These were described and illustrated in the November number of MARINE ENGINEERING, and the diameters are given in the accompanying table. The high-pressure cylinders of the two engines on one shaft adjoin each other, but are separated by a water-tight bulkhead which extends above the top line of cylinders. The high-pressure cylinders are mounted on top of the first intermediate; the second intermediate valve chest adjoins the first intermediate cylinder; and next in order comes the second intermediate, then the low-pressure valve, and the low-pressure cylinder. The valves are operated by a Stephenson link motion and are all of the piston type, except that on the low-pressure cylinder, which is a double slide valve. The motion for the high-pressure valve, which is at the side of the cylinder, is carried by a rock shaft from the first intermediate valve stem. There is one main steam pipe to each pair of engines, leading to the valve chest of the forward sets, from whence it is piped with an expansion joint to the valves of the after sets. The cylinders are cast iron, mounted on cast-steel columns front and back. These columns are very beautiful castings; the outsides are smoothed up and painted to a fine polished surface; the bed plates are also cast steel. A very elaborate system of oiling is fitted and oil is introduced into all the stuffing boxes. The connecting rods are rather short and the shafting for each engine is in two sections, one for the low-pressure cylinder and its slide valve and one for the other two cranks. There are two journals for each crank, with wrought-steel slabs. The large half of each eccentric is of cast steel and the other of cast iron. Ordinarily the working platform for both engines is opposite the high-pressure of the forward engine, but each

FIRST-CABIN DINING SALOON, STEAMSHIP KAISER WILHELM II.

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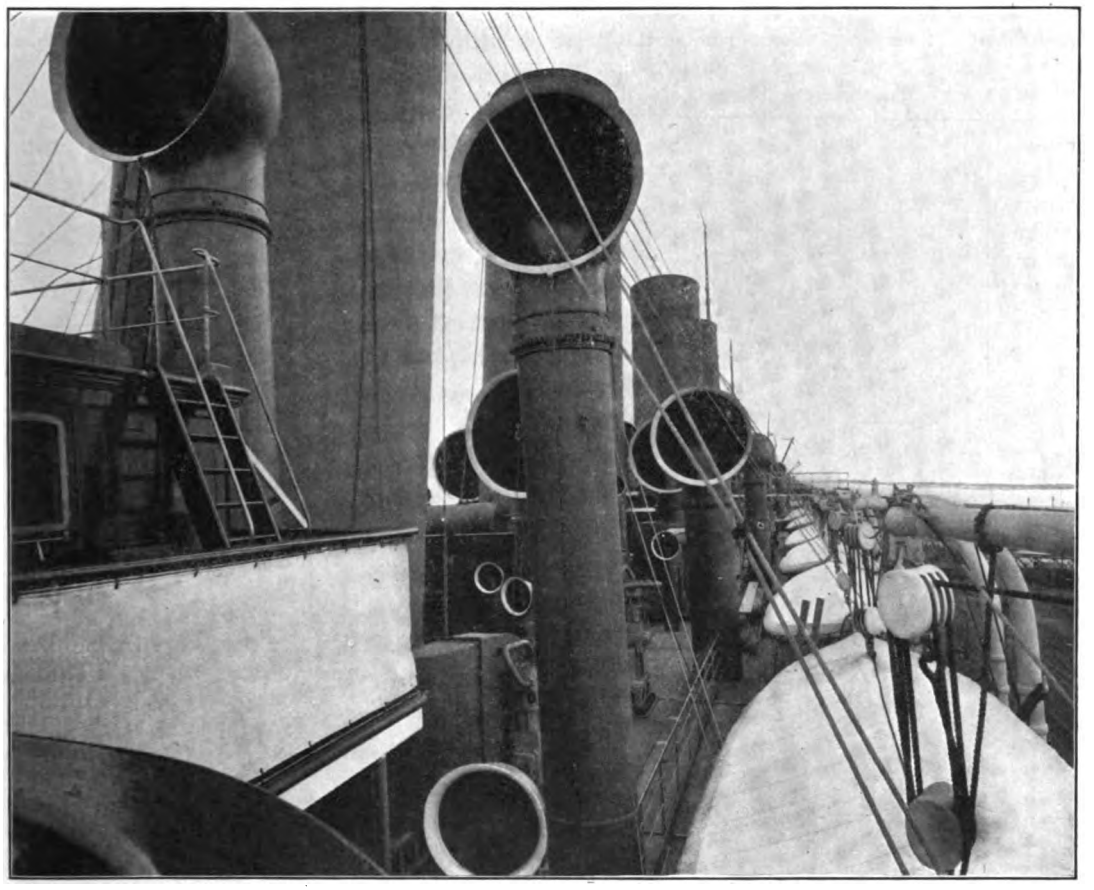
engine may be controlled from its own compartment, or both may be operated from the after engine room; in case it is necessary to uncouple the engines this may be done by removing the coupling bolts of the crank shaft between the engines and by uncoupling the reversing shaft. Each engine has a Brown reverser on the back of the first intermediate-pressure cylinder. Also in each engine room are installed an independent condenser and a double-cylinder Weir air pump. Weir feed pumps are also installed, and one pump of this make is used for lifting the water from the hot well to the heater. Aft the thrust bearings, which are of the horse-shoe type, each one being fitted with thirteen collars, is placed the dynamo room, which in truth is a division of the shaft alley. Between the shafts four direct-connected Union Electricity Company's compound generating sets are placed, for supplying current to 2,700 25-candle-power lights, and aft of these are two carbon anhydride refrigerating machines, each mounted on its condenser. The main switchboards are placed above the dynamos and lead to the distributing switchboard placed on the top platform of engine room.

On the recent trip an approximation was derived of the effective horse power of the starboard engine by placing an apparatus on the line shaft which measured torque or twist of the shaft between two points about three feet distant from each other longitudinally. The device is evidently a result of the experiments recently carried on by the North German Lloyd to ascertain the twist of propeller shafts, yet the variation in quality of material seems to indicate that this method is not reliable and can only be used on a comparative basis for one shaft.

In each engine room is a high-duty fire pump, and in this compartment may be seen the details of the Dörr system of operating bulkhead doors above mentioned; hand gearing is also provided for all doors.

Passing forward through a long tunnel in the coal bunkers one enters the boiler room, the arrangement of which is: At the after end are three single-end four-furnace boilers and at the forward end are three double-end eight-furnace boilers. A stokehole next forward is used for firing the opposite ends of these double-end boilers and three other double-end ones, and from another stokehole the forward ends of latter-named boilers are fired. The thwartship coal bunkers separate the boilers just mentioned from the forward battery, namely, six double-end and four single-end. In each stokehole is an ash ejector, operated by a powerful pump placed in a bunker recess. Side bunkers extend the full length of the boiler rooms, and there is also placed in each compartment a ballast pump. Natural draft is used and there are four stacks.

The high class of steel work and fittings is shown as



STEAMSHIP KAISER WILHELM II., LOOKING AFT FROM THE BRIDGE.

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much down below as above decks. The riveting is very neat and the plates are cut straight; thus in the bulkhead stiffeners the heel of the angle on almost any stiffener lies perfectly flush with the edge of the plate. In the engine room the structural work looks like some special job. One is forced to believe that this is the character of work turned out by the great yard at Stettin, for it would be practically impossible to do both this kind and a second grade of work. While this high class of work may be no stronger than the other class, it is certainly more satisfactory, and, when once adopted, would be found no more expensive; in fact, so-called "cheap" work is probably the most expensive.

As is stated at the beginning of these remarks, the *Kaiser Wilhelm II.* may be looked upon as the finest production of the shipbuilding yards, and in her has been reached the greatest triumph of the ocean.

NAME—Kaiser Wilhelm II. NATIONALITY—German. TYPE—Ocean express steamer.
LAUNCHED—August 12, 1902. BUILDER—Vulcan Shipyard. OWNER—North German Lloyd.

Length over all	706 ft. 6 ins.	Height of engines over all	43 ft. 4 ins.
Beam	72 " 0 "	I. H. P., designed	40,000
Depth to upper-promenade deck	72 " 7 "	Revolutions	80
" of water bottom	7 " 0 "	Speed	23 1-2 knots
Draft, load	29 " 6 "	Condensers, cooling surf. each	11,732 sq. ft.
Displacement, launching	11,200 tons	Propellers, diameter	22 ft. 10 ins.
" load	26,500 "	Shafting, length, total	230 ft.
Coal bunker capacity	5,700 "	Weight, total	65,000 lbs.
Water ballast	2,097 "	Diameter, forward crank	20.87 ins.
Fresh water	1,068 "	" after "	25 "
Engines, 4 sets, quadruple, twin screws		" propeller shafting	25.4 "
Cylinder dia.	37.4, 49.2, 74.8, 112.2 ins.	Boilers, 12 double-end, 7 single end	
Stroke	70.8 "	Pressure	213 lbs.
Length of two engines	92 ft. 0 "	H. S., total	10,000 sq. ft.
		G. S., "	3,121 " "
		Length, boiler rooms & coal bkrs.	295 "

Construction for Boston Navy Yard.—Official notice has been sent to the commandant of the Charlestown (Boston) Navy Yard that one of the two steel training ships authorized by the last Congress will be built at that yard. The ship will cost about $337,000 outside of her armament.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 135 vessels of 44,619 gross tons built in the United States and officially numbered during the month of April, 1903.

GRADUAL COLLAPSES OF FURNACE CROWNS: A SUGGESTED EXPLANATION.*

BY H. M. ROUNTHWAITE, ESQ.

When a furnace crown is under usual working conditions, the side exposed to the fire will be hotter than the side in contact with the water, and this difference of temperature will depend upon the intensity of the combustion, the pressure of steam carried, the condition of the surfaces as regards soot, scale, grease, etc., and also to a slight extent upon the thickness of the plate.

Also, the hottest part of a furnace crown is probably that adjacent to the longitudinal center line, since that part is placed normally to the direction in which most of the radiant heat leaves the fire, and is also worse off as regards water supply than other parts. The water supply to the central portion of the crown must come mainly from the sides, and must, therefore, contain a considerable proportion of steam bubbles which have not had time to rise clear of the plate lower down the curve of the crown; and, as the currents from the two sides meet and change direction near the center line, an eddy is formed, and the water close down on the center of the plate tends to be somewhat stagnant, and so to contain a greater proportion of steam bubbles than the water elsewhere, and, therefore, to have also a higher mean temperature.

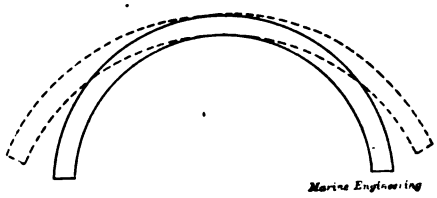

FIG. 1.

Let it be granted, then, that the fire side of the plate is hotter than the water side, and that the temperature is a shade higher near the center line than elsewhere.

If the crown plate were a free strip of metal, as indicated by Fig. 1, this distribution of heat would cause it to change its form from that shown by the full lines to such a one as is indicated by the dotted lines, owing to the greater expansion of the layers on the fire side. The furnace tube does not consist of such free strips of metal, but it is well known that some action of this kind does take place, and that, in spite of the restraining forces, or resistances, the furnace tube does assume a more or less oval form in cross section, the sides going out and the crown and bottom plate approaching one another.

But the resistances prevent the sides moving out to anything like the distance due to the difference in the expansion of the two faces of the plate, and the result is that the inner layers are crushed up to some extent, the outer ones being at the same time possibly stretched to some minute extent, but the marked effect is the crushing.

As another example of a similar action, the case of a hot bearing brass may be referred to in passing. The heated inner layer cannot at once expand, because of the restraint due to the cooler outer layers, and it is crushed

*Read at the Spring Meeting of the Forty-fourth Session of the Institution of Naval Architects, April 1, 1903.

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in consequence; and when cool again, it shows minute cracks, which are caused by the action of the shaft pressure in restoring the inner layer to its original length.

Assuming now that the layers next the fire have been more or less crushed in this way, suppose further that the fire door is opened (for the purpose of firing or of cleaning the fire), or that the ashpit damper is closed, or the fire banked, and that the furnace temperature falls in consequence. Then, if the crown plate were free, it would tend to return to its original form as the temperature fell, but, owing to the crushed and shortened inner layers, it would go further and become an oval with the longer diameter vertical if it were allowed to become quite cool again. But the crown plate is restrained, not free, and it probably does not even return quite to its original semi-cylindrical form when cooled, because the exposure to heat has been long, and some molecular readjustment will have taken place, whilst the frequent periods of cooling are short. Thus, the crushed layers on the fire side are trying to pull in the sides of the furnace and the resistances are preventing more than a partial readjustment of form, with the result that the crushed layers are now subjected to stretching or

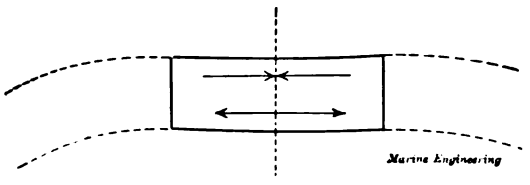

FIG. 2.

are in a state of tensile stress. But this tensile stress in the layers next the fire sets up a corresponding compressive stress in the layers next the water, and this stress is always tending to crumple them up or crush them together. The important point is that, although these stresses are not sufficiently great to produce immediately a perceptible effect, the same series of actions and reactions is gone through dozens of times in every day during which the boiler is under steam, the furnace tube "breathing" with every change of temperature, *and their effect is cumulative.*

An exactly parallel case, which will serve as a very good illustration, is that of the continued shrinkage of an iron ring when alternately heated to redness and quenched in cold water. The outer layers are suddenly caused to contract, and, in so doing, they crush the inner portions which are still in a hot condition; and this effect may be reproduced a number of times, the ring increasing in cross section and diminishing in diameter with each repetition.

Now, if stresses as above described act in every element of the furnace crown (their disposition being that indicated on this page in Fig. 2), their general tendency is evidently to straighten the curvature and eventually to produce a minute flat at some point—that point being determined as is the point at which contraction of area takes place in a tensile test piece, viz., by some defect or weakness too slight to be observable. And in the case of the furnace crown, the minute flat will evidently tend to appear at the hottest point in the circumference —the top.

Let the full line in Fig. 3 represent such a flat after the cumulative effect of the forces has made it quite perceptible, but drawn, for clearness, in an exaggerated manner. Then it appears that, as regards any compressive stress that may now come upon the inner layers, there are two weak points at the angles *A, A,* and the crushing effect of such a stress would be localized at these points, with the result that the section would tend to gradually take the form indicated by the dotted lines, *i.e.,* the shoulders would hunch up and the center part go down, thus gradually producing a pocket in the crown plate.

The explanation of the fact, so often observed, that such a pocket will come down so far and then stop may be that, when it attains a certain depth, it acts as an expansion joint, and allows the furnace tube to "breathe" as much as the changes of temperature compel it to. That when set back such a pocket tends to form again in precisely the same position is exactly what might be expected when the material is injured, quite imperceptibly no doubt, but still fully enough to again determine, or localize, the effect of the continually acting stresses.

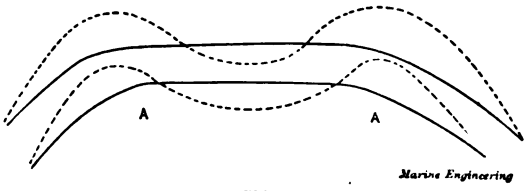

FIG. 3.

As to the effects of grease, scale, etc., although these would hasten and intensify the action in question, it is clear that they are only accessory or subordinate causes, the primary cause being simply change of temperature.

It would also follow, if this is the real cause of these gradual collapses, that they will be less frequent in boilers fitted with mechanical stokers, other things being equal, and it would be interesting to know whether any such difference has been observed.

Further, it would follow that stiffened and corrugated furnaces will be more liable to collapse than those which can change form, or "breathe" more freely, since it is the *resistance* to breathing that causes the trouble. A plain furnace of rather thicker plate should have the advantage over those of more rigid type, as the depth of girder (*i.e.,* the difference between the outside and inside radii) is less in the former than in the latter. Also, the short and rigid furnaces of marine boilers will suffer more from these collapses than the longer and less rigidly held furnaces of Lancashire boilers. And the cure lies evidently in such manipulation of the furnace when at work, or alterations in its construction, or in such additional appliances, as will reduce, or entirely prevent, changes of temperature.

Work on the Battleships.—60,000 pounds of steel a day are being built in the two battleships *Rhode Island* and *New Jersey*, under construction at the Fore River shipyard. Backing for the forward turret barbette is being set up.

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Light-Draft River Ice Breaker.

One of the most excellent light-draft ice breakers for small river service is the *Schwarzwasser*, built at the yard of T. W. Klawitter, Danzig, Germany. She is 125 feet long between perpendiculars, 119 feet 5 inches long on the water line, 20 feet molded beam, and 10 feet 8 3-4 inches deep. The *Schwarzwasser* is a twin-screw steel vessel with flat bottom, cut-away stern, and very full lines in the fore body, so as to make her able to run high on the top of the ice, breaking the same through her weight, and for that purpose the boiler is located well forward. In the middle of the vessel, over engine, boiler, and cabins, the deck is raised to about 2 feet 4 inches, to obtain the necessary head room.

The complement of officers and men consists of master, engineer, two firemen, cook, and five deckhands. In summer-time the vessel will be used for inspection service, and has for that purpose a state room and a saloon for government officers. The vessel is well adapted to the service, except that at times the change in trim when breaking the ice lowers the water on the crown sheets of the long locomotive type of boiler. A shorter boiler would be preferable.

Seven water-tight bulkheads divide the vessel into eight compartments. Between the stem and frame 8 is the store room; the accommodations for firemen, cook, and deckhands are located between frames 8 and 19; the engine room, with the two engines and the dynamo, is in the next space; the boiler, with the wing bunkers for 32 tons of coal, occupies the fourth compartment from frame 29 to 47. In the space between frames 47 and 59 are, on port side, the state room for the government officer, and, on starboard, the pantry, watercloset, and hallway, with the stairs from the main deck; the steps are of oak, the standards and the rail of mahogany. Then follows the saloon, which occupies the full width of the vessel. A writing desk is placed at the front end in the middle of the saloon, while on the after ends on port and starboard two sideboards are arranged. Two tables, one stool, and a small sideboard with mirror complete the outfit. The floor is covered with linoleum. The saloon receives the necessary light from three side lights of 10 inches clear in diameter placed in the shell, and five side lights of the same size arranged in the front bulkhead of the raised deck. This saloon is finished in oak with maple panels. In the sixth compartment of the vessel, extending from frame 59 to 64, are the cabins for the master and engineer, well equipped; their mess room, from frame 65 to 70, occupies the full width of the vessel. The entrance to these accommodations is from a companionway on deck. The mess room is fitted with sideboards on the after end, with two long leather-cushioned seats, and two 10-inch side lights on each side. The space between the bulkheads 70 and 72 is provided for chain locker, while the eighth part is used for store room.

A small hatch, 33 inches by 25 inches, is arranged in the deck over the store room aft. The companionway and skylight over the crew's cabin are built of teak. Two iron steps with stairs of checkered plates lead to the raised deck. The entrance to the engine room is at the after end of the engine house through a teak companionway; skylight over the engines is of the same material. The engine house is built of 5-32-inch plates, the top being fitted with four fidley hatches with hinged covers. Arrangement for towing is made on the after end of this house. The galley is on deck in the boiler house. Two small side houses are built on each side of the bulwarks, extending from frame 40 1-2 to frame 44 1-2, the tops of which are formed by the saloon deck, which extends for the house's length over the whole width of the vessel. A small boat is hung on davits on the port side near the engine house. The deck over the boiler is built on both sides, between boiler house and bunker walls, of checkered plates. Deck beams are cut at the bunker walls, so that the boiler may be taken out of the vessel without removing the deck planks. The deck saloon in front of the boiler house is finished in oak and is used for smoking room by the officers. On the saloon deck is the pilot house with the steering gear. A searchlight is arranged on the roof of the house.

The material for hull is Siemens-Martin steel. The rudder post is a forging 5 1-2 by 2 inches, rudder stock 4 3-4 inches in diameter with 3 1-8-inch pintles; the rudder plates are 3-16 inch thick, and the rudder frame is filled in with wood. The stem is constructed in its upper part as an angle bar 4 by 4 by 3-4 inch thick, but in and under the water line it is flattened out into a shoe.

The frames are 3 by 2 1-2 by 9-32 inch, spaced 19 3-4 inches centers. There are two cant frames on each side of the vessel. All rivet holes for the longitudinal laps of the shell plating are drilled after fitting up the plates. The heel bitts are of the same scantling as the frames, 2 feet 8 inches in length, having three rivet holes on each side of the center keelson for riveting the frames together. The reverse frames are 2 1-8 by 2 1-8 by 1-4 inch angle bar, extending from the center keelson to 4 inches above the side stringer. The straps are 18 inches long and scored through the keelson, riveted with 2 rivets on each side of the keelson to the reverse frames and floor plates. The floor plates are 11 inches high and 9-32 inch thick, reduced to 1-4 inch at ends, except in the engine and boiler room, where they are 5-16 inch thick. All floors are connected by double angles with the center keelson.

The collision bulkhead is 1-4 inch thick; all other bulkheads are built of 3-16-inch plates for the lower parts and 5-32-inch plates for the upper parts. All bulkheads are fitted to deck with double angle bars 3 by 3 by 1-4 inch, and to sides with double frames, both edges of which are planed and calked water-tight. The bulkhead stiffeners consist of angle bars 2 1-2 by 2 1-2 by 1-4 inch, laid on one side vertically, 24 inch centers, while two angles are arranged horizontally on the other sides, except the bulkheads under the raised deck having three horizontal stiffeners. All stiffeners of the collision bulkhead are connected with knee plates to the shell and the deck. The bulkheads are tested by hydrostatic pressure corresponding to a head of water 12 feet from the bottom of the vessel. The deck beams are arranged on alternate frames and consist of angle bar 5 by 3 by 11-32 inch, and connected to the frames by 5-16-inch brackets. The camber is 5 inches.

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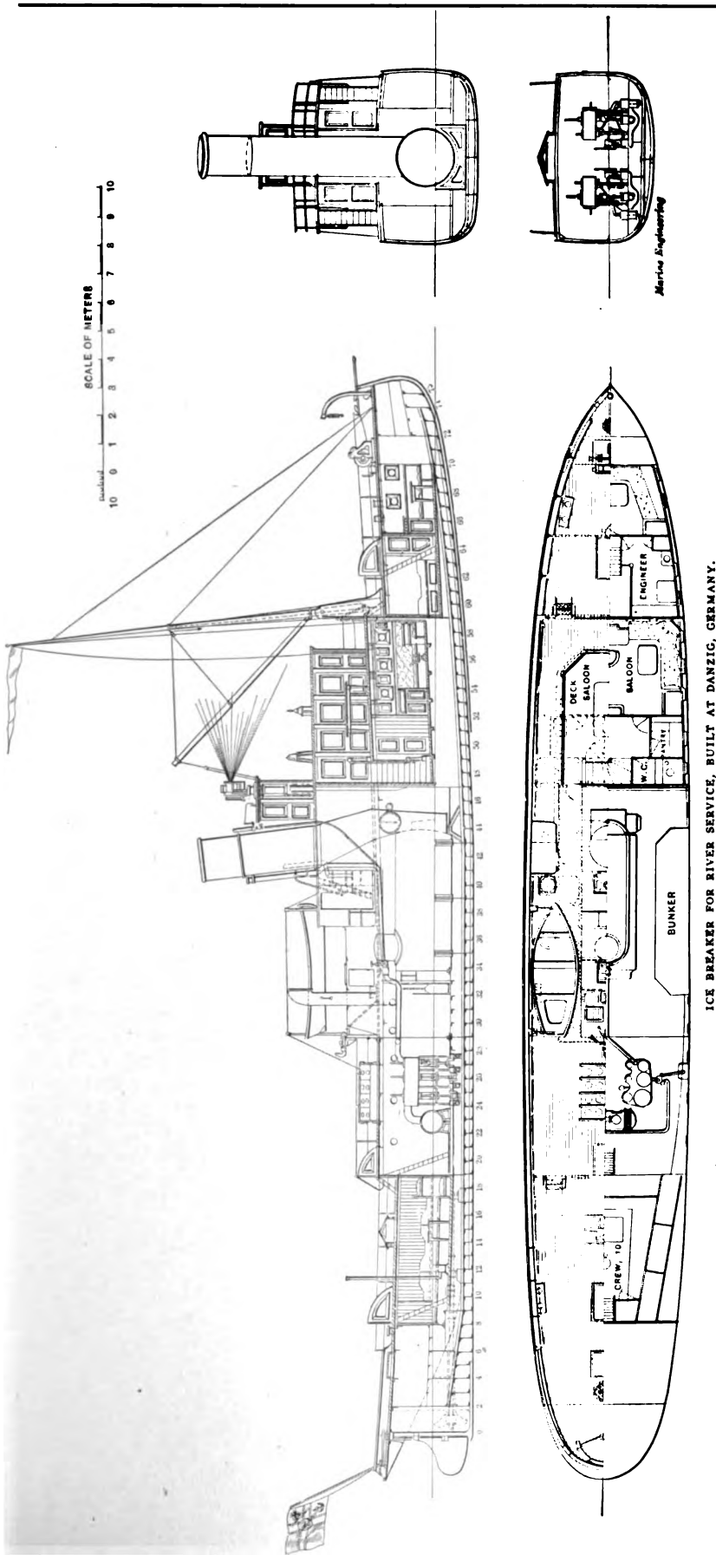

ICE BREAKER FOR RIVER SERVICE, BUILT AT DANZIG, GERMANY.

The keelsons consist of center keelson, side and bilge keelsons. The center keelson is of 5-16-inch plates, connected with the keel plate by two angles 3 1-2 by 2 1-2 by 5-16 inch, reduced at the ends to 9-32 inch. The rider plate is 9 inches wide by 11-32 inch thick and the upper bars are of same size as lower ones given above. The butts of the center keelson are treble riveted with double butt straps of two-thirds of the thickness of the plates they connect. The side and bilge keelsons are made up of double angles, 3 1-2 by 2 1-2 by 5-16 inch, with intercostal 9-32-inch plates attached to shell by single 2 1-2 by 2 1-2 by 1-4-inch clips.

At the load-water line a side stringer 12 inches wide is built of 5-16-inch plates. The deck stringer bars are 2 3-4 by 2 3-4 by 9-32 inch. One angle of the same size is arranged on the inner under edge of the plate and 9-32-inch knee plates are riveted on alternate frames to the stringer and frames. The deck-stringer plate is 24 inches wide by 5-16 inch thick.

The 6-inch waterway is bordered on the outside of the sheer plank by the gutter bar, 2 1-4 inches by 2 1-4 inches by 1-4 inch thick. Deck planks are of white pine 4 inches by 2 3-4 inches. The sheer plank on the gutter bar and margin plank on the deck openings are of oak. All deck planks are fastened by means of 5-8-inch galvanized bolts. Tie plates, 8 by 5-16 inch, are run at all deck openings.

The keel plate is 20 inches by 1-2 inch amidships, reduced in the after body to 7-16 inch, while it is increased forward to 19-32 inch. The bottom and bilge plates are 15-32 inch amidships, decreased in the after body to 13-32 inch, but increased in the fore body to 9-16 inch. The thickness of the side plating is, beginning at the stem, for the first fourth of the vessel's length 9-16 inch, reduced for the next two-fourths almost 1-32 inch, and having on the last fourth plates of

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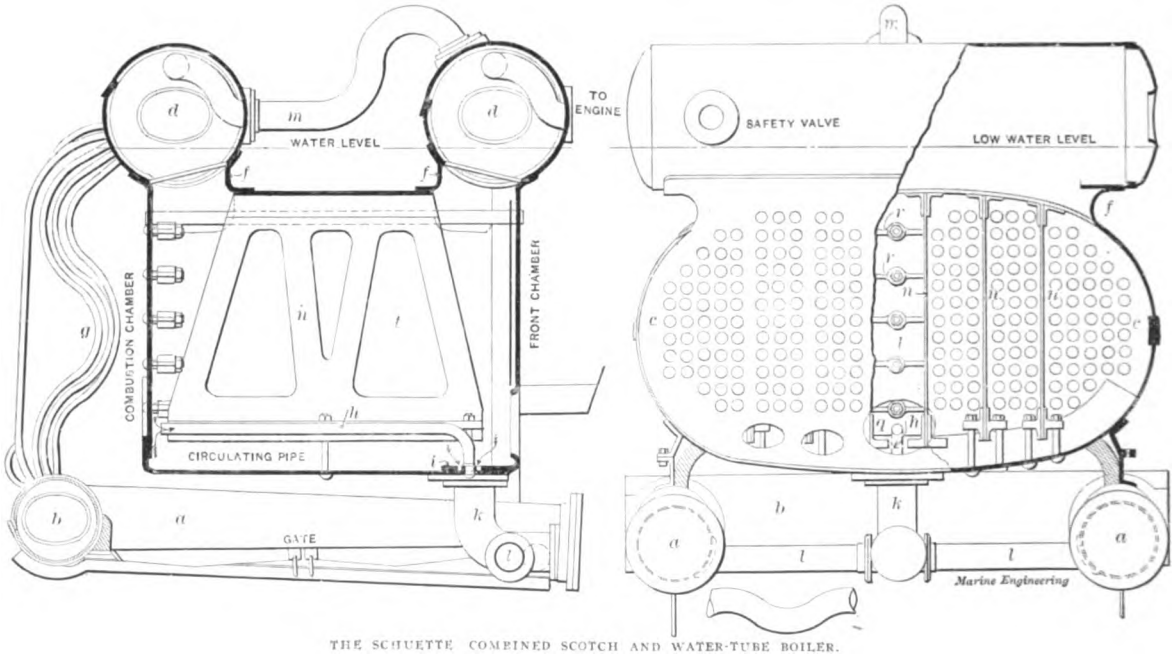
15-32 inch in thickness. The sheer strake is 13-32 inch thick amidships, reduced to 11-32 inch at the ends.

Rivets 5-8 inch in diameter are used for riveting the frames with the reverse frames, floor plates, deck-beam knees, main-deck stringer plates and ties. The rivets in the butts and longitudinal seams of the shell, in the frames for connecting the same with the shell, and in all keelson, stringer plates, and angles, are 3-4 inch in diameter. All seams of the shell plating are double riveted. The butts of the keel plate, deck stringer, center keel, and all tie plates are treble riveted. The center keelson plate has double butt straps of two-thirds of the thickness of the plates they connect. All other butts of the shell plating are double riveted. The bulkhead and bunker plates are riveted with 1-2-inch rivets and the deck houses with 13-32-inch rivets.



THE SCHUETTE COMBINED SCOTCH AND WATER-TUBE BOILER.

The boiler is of the locomotive type, 6 feet 8 inches in diameter, 17 feet 1 1-2 inches long, and built for a working pressure of 140 pounds per square inch. The two engines are of the vertical, triple-expansion, condensing type, having cylinders 10, 15, and 23 3-4 inches in diameter by 8 inches stroke. They indicated 520 horse power at the first trial trip.

Battleships and Cruisers of the Five Greatest Sea Powers.—A most interesting chart on the warship building of the five greatest shipyards is given in the March number of *Marine-Rundschau*. The chart is about 3 by 4 feet, and is laid off with co-ordinance of displacements and years. For each country, England, France, Russia, United States, and Germany, there are two maps, one for the battleships and coast-defence vessels and the other for all classes of cruisers and gunboats. The system adopted is to lay off spots for each ship built, and thus the chart clearly shows the division of warship construction and the variation of displacement during succeeding years. Opposite each spot are given the name, speed, and displacement of the corresponding ship.

A NEW TYPE OF WATER-TUBE BOILER.*

Regarding the question of water-tube boilers in general, practice has shown that the large-tube boilers are easier to clean, while the small-tube boilers give better efficiency and are of lighter weight. Which type of water-tube boiler has a distinct advantage over others, or that can be compared in point of operation and efficiency with the Scotch boiler, it is impossible to say at the present moment, as our knowledge of water-tube boilers for ship use is as yet very meager.

The position that the German Navy Department has taken regarding water-tube boilers is best illustrated through the mixed boiler plants as installed on the latest battleships, *Kaiser Wilhelm II.*, *Kaiser Friedrich III.*, *Wittelsbach*, and others of this type.

In these mixed boiler plants the primary object was to install cylindrical boilers of such power as to suffice for ordinary cruising purposes, and so that when it becomes necessary to get up full speed quickly and steam at the maximum power the water-tube boilers will be placed in service. In these plants the cylindrical boilers are approximately one-third of the power, water-tube boilers of the small-tube, light-weight type making up the remaining two-thirds. The small-tube water-tube boilers were here used, in spite of the difficulty of cleaning, in order to make up for the greater weight of the Scotch boilers, so that the total boiler weight is no more than if large-tube water-tube boilers were used. This has led to the design of a combined Scotch boiler with a small-tube water-tube boiler, called the Schütte boiler, which is of the oval fire-tube type, with small-tube water tubes behind the combustion chamber.

The fire-tube boiler, *c*, of oval or flat form, has two steam drums, *d* and *d*, which are connected to it for almost the entire length by means of collars, *f*. The boiler

*Special translation for MARINE ENGINEERING from an article on the "Water-Tube Boilers for Merchant Ships," by Constructing-Engineer Benetsch, of the Marine Academy at Bremerhaven.

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is carried by three lap-welded tubes, *a*, *a*, *b*, shaped U-fashion, of about 15 to 20 inches diameter. Into the rear tube are fastened the small water tubes similar to those employed in the Thornycroft boiler. The Schütte boiler consists, therefore, of the following four parts:

First.—A U-shaped foundation, *a*, *a*, *b*, which forms the lower legs of the water-tube boiler.

Second.—An oval main boiler with numerous fire tubes, *c*.

Third.—Two steam domes, *d*, *d*, which are placed across the top of the boiler.

Fourth.—A large number of water tubes, which, by bending them twice, divide the combustion chamber into three parts.

The main boiler is so connected to the foundation tubes by means of brackets that the heating of the various parts will not cause undue strain to any portions of the boiler.

In order to obtain a good water circulation from the main boiler, the foundation tubes and the bottom of the Scotch boiler are connected by means of large tubes, *k* and *l*, and inside the Scotch boiler is a circulating tube, *h*. Flanged connections are made between the various members. The water in this wise passes from the Scotch boiler through the circulating tube *h* down the tube *k*, from which it branches through the pipes *l*, *l* into the main drums *a* and *b*, from there through water tubes *g* into the drum *d* and back into the Scotch boiler. As the first steam is formed in the water tubes, the circulation is naturally immediately set up on the starting of the fires, which tends in a few minutes to heat gradually the total water in the boiler. The fire on the grate underneath the floor of the fire-tube boiler warms the bottom of the boiler; the gases then pass between the water tubes in the combustion chamber and forward through the fire tubes into the smokestack. On the way to the stack the gases, which are at a temperature of 600 to 700 degrees, pass the forward steam drum *d* and superheat the steam, so that the steam taken from this drum is constantly dry.

Separating the combustion chamber into three parts by means of the tubes has the following advantages: The gases are thoroughly mixed, and a portion of them reach the lower fire tubes better than in the ordinary Scotch boilers.

One difficulty, however, that this boiler possesses is that, owing to its oval form, the top and bottom members have to be connected by means of anchor bolts, marked *n* in the drawing. What on the one hand is detrimental is on the other an advantage, as:

First.—The arrangement of a large number of fire tubes over the whole breadth of the boiler without unduly increasing the height of the same, is possible.

Second.—The better handling in cleaning of the boiler and the combustion chamber forward.

Third.—A good connection to the steam dome, which can be easily cleaned and from which the remaining portion of the boiler can be gotten at through the collars *f*.

After several months' service, scum was found only in the lower chamber, which could be easily cleaned by means of a manhole. The staybolts at the bottom of the boiler are so arranged that in order to clean the boiler they are not in the way of the handholes and manholes *p* and *q* in the forward end of the boiler.

For several years, during which the boiler has been in use at the shipyard of G. Seebeck and on the yacht *Lensahn*, these staybolts have given no trouble whatsoever. They should give no more trouble than the staybolts in a locomotive boiler or in the combustion chamber of a return cylindrical boiler. Their number, too, is much smaller than in the usual boiler of the same heating surface. This boiler is also from 40 to 45 per cent. lighter in weight than boilers of similar heating surface and power of the Scotch type. Without forcing the boiler on starting, in one hour 180 pounds pressure was obtained from feed water of 48 degrees temperature. The circulating apparatus necessary on Scotch boilers is not necessary, as the type of boiler itself effects a circulation. The good circulation has a further effect of tending to keep the small tubes in the rear combustion chamber cleaner than usual, thus obviating one of the objections of this type. Actual investigation showed that these tubes were always clean.

The grates being situated underneath the shell, there is no large body of dead water, as is generally found in Scotch boilers. This water is hard to move and gives rise to many leakages.

		Scotch.	Schütte.
Type		Scotch.	Schütte.
Builders		G. Seebeck.	G. Seebeck.
Date built		1901	1901
I. H. P. at nat. draft		500	500
Heating surface, sq. ft.		1711	1685
Grate surface, sq. ft.		52 1-4	45 1-4
Ratio H. S. to G. S.		32.6	36.2
Pressure, lbs. per sq. in.		190	190
Weight	Bare boiler, lbs.	65,674	37,480
	Boiler and water, lbs.	106,581	55,120
	Boiler, water, grates uptake stack, covering, etc., lbs.	115,081	65,694 about 43% less
Ratios	Bare boiler / I. H. P. lbs.	131.3	74.9
	Boiler and water / I. H. P. lbs.	213.1	110.2
	Complete boiler / I. H. P. lbs.	230.2	131.4
Consumption coal of 13,500 B. T. U. with feed water from and at 212 deg.		9.5 to 10	10.8 to 11.1

COMPARISON BETWEEN SCOTCH AND SCHUETTE BOILERS.

The two steam domes, which are connected by the pipe *m*, have the same cubic capacity as would be given to the steam room in a Scotch boiler, thus overcoming one of the disadvantages of the water-tube boiler, which is generally deficient in steam space. This allows of a better feeding of the boiler and, as the steam is superheated in the drum *d*, prevents priming to a great extent and insures dry steam. Outside of the man- and handholes there are no connections which can become leaky. In principle the Schütte boiler and the Scotch boiler are very similar and the coal consumption of the two is about the same, consequently some 15 to 20 per cent. better than the water-tube boilers in use on ships. The above table shows a comparison between a Scotch boiler and the Schütte boiler, both boilers being built at the same time at the shipyard of G. Seebeck at Bremerhaven.

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The first boiler after these patterns was built at the shipyard of G. Seebeck, at Bremerhaven, for his own use, and such good results were obtained therefrom that the yacht of the Duke of Oldenburg was equipped with the same.

To show the rapidity with which steam can be raised from the cold boilers without forcing, a steaming test was made with the shipyard boiler. This boiler had a heating capacity of 1,540 square feet and a grate surface of 33 square feet, which makes the ratio 1:47. This boiler was in constant use until January 27, 1901, and on January 28, at 5.30 A.M., the temperature was 40 degrees. The trial lasted from 4.45 A.M. until 12 noon.

From 5.45 A.M. to 6.25 A.M., from the time of starting of fire until 15 pounds steam showed on the gage, 800 pounds coal were used: from 5.45 to 6.55, when 191 pounds were registered, 1,380 pounds of coal were used, while in one hour and 10 minutes 16,600 pounds of water were brought from 40 to 369 degrees.

VESSEL.

Builder	Howald, Kiel.
Length between perp.	142 ft. 6 in.
" over all	174 " 9 "
Beam	25 " 3 "
Draft	11 " 7 "
Displacement	465 tons
Wetted surface	4,315 sq. ft.

ENGINE.

Type	Triple exp.
Builder	Howald, Kiel.
Revolutions per minute	180
Pressure	190 lbs.
High-pressure engine	13 in.
Intermediate "	19 3-4 in.
Low-pressure "	31 1-2 "
Stroke	18 in.
No. Boilers	2

BOILER

Type	Schütte.
Builder	G. Seebeck.
Number	2
Grate surface, total	90 sq. ft.
" " each boiler	45 " "
Heating surface	3,280 sq. ft.
" " each boiler	1,640 " "
Pressure	190 lbs.
H. S. ÷ G. S	36.2

TRIAL RESULTS.

Speed, knots	13.8	14.25
I. H. P.	860	1068
Cut-off H. P. cyl.	.6	.76
I. H. P. per sq. ft. G. S.	9.55	11.90
I. H. P. per sq. ft. H. S.	.25	.32

TESTS OF SCHUETTE BOILER.

At 7 o'clock the machinery of the works began operation: from 7 until 12 noon coal weighing 3,085 pounds was consumed, with a resulting evaporation of 29,500 pounds of water, the feed-water temperature being 4[illegible] degrees and that of the steam at 396. The resulting evaporation was 9.9 pounds of water per pound of coal from and at 212 degrees; 24 pounds of coal were burned per square foot of grate per hour.

Herewith are given table of dimensions of the yacht which was fitted with boilers of this type, and the results of a six-hour trial, during which 1,068 H. P. was developed on 1,760 pounds of coal per hour. This would be a consumption of 1.68 pounds of coal per H. P. per hour, including all auxiliary machinery, steering engine, etc., which is very economical for so small a plant.

This type of boiler could be properly installed with slight modification in launches, etc., on account of its quick steaming and adaptability, and at present an auxiliary boiler of this type is being built for the cable ship *Nordenheim*, building at the Vulcan Iron Works at Stettin. This boiler will have 9.5 square feet of grate, 300 square feet of heating surface, and will be designed for 150 pounds of steam.

Bronze Tablet for American and British Sailors.

The first monument ever erected to commemorate the deaths of American and British sailors fighting side by side is shown in the accompanying engraving. It is a bronze tablet about 3 1-2 feet square with a design and inscription in bas-relief. The tablet is erected in the Chapel of St. Peter at the Mare Island Navy Yard, California, and was unveiled on July 17, 1902, in the presence of Admiral Merrill Miller, several officers attached to the station, American and British sailors and marines, and citizens of Vallejo and San Francisco. Upon the tablet are engraved the names of the officers and men who fell during the brief war in Samoa in 1899.

Six-Masted Schooner.—The work of building the six-masted schooner *Wm. L. Douglass*, at the Fore River shipyard, is being pushed night and day. The vessel is in frame and it is expected will be launched in August.

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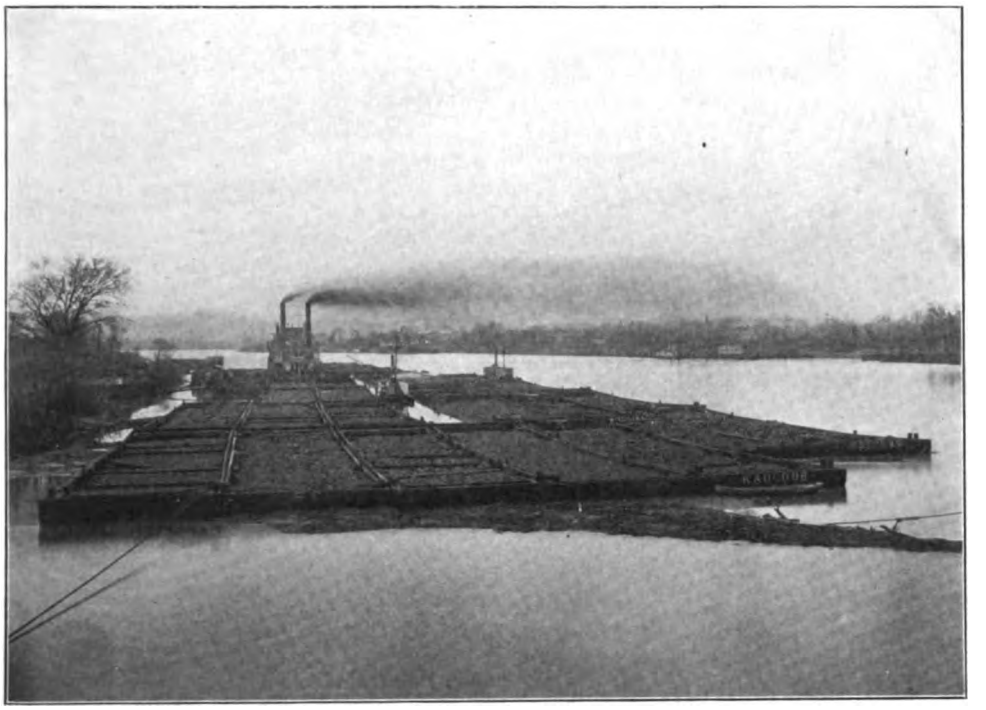

COAL BARGES AND TOW AT POINT PLEASANT, KANAWHA RIVER.

THE COAL FLEETS OF THE GREAT KANAWHA RIVER.

BY H. C. FITHIAN.

Under the heading of the "Ohio River Coal Fleets," published in MARINE ENGINEERING for October, 1901, were described by the writer some of the unique features of this immense inland commerce, and the present article has been written to continue the general subject and give further particulars, especially applying to river traffic on the Great Kanawha.

The towboat, unlike the passenger packet, has no set time of arrival and departure. As a rule, when in port the boat is engaged in harbor duty. In fact, while steam is up it is seldom that the boat is not on duty.

Each large coal company has several harbors within a few miles of one another at the terminals. The harbors form what might be called the company's storehouse, where the barges are accumulated for future disposal. The harbors are in sheltered spots on the river banks, affording protection to the barges against ice and current. The barges in the harbor are usually referred to as the "fleet," as distinguished from the "tow." In the fleet the pieces are not placed with the same rigidity as they are in the tow, and, owing to the swells from passing boats, wind, rising or falling water, etc., loosen their connections somewhat and need to be "straightened up," which is done by the regular towboat in the absence of the harbor boat. The latter is a small towboat capable of handling a few pieces at a time between different landings.

The steamboat seldom lays up at Cincinnati; after delivering her loaded pieces to the different harbors, she "hitches up" her tow of empties for the return trip, generally on the same day. The steamboat generally lays up for a few days at the upper end of the route.

On the morning of the 24th of February the tow, made up of steamer *E. R. Andrews* and thirty-one pieces, all but two of which were empties, left the harbor at Coal Haven, Cincinnati, Ohio, bound for Point Pleasant. The craft of the tow are placed ahead and the smaller ones in the "pool or duck pond," which is an open space directly ahead of the steamer. In this instance the fuel flat and *Boy* were the only pieces not empty and were placed inside of the "pond." The fuel flat, which carries coal for the steamboat, is in general like the barge, except that it is of smaller dimensions than the barges, being about 90 feet long, 18 feet wide, 6 feet 6 inches deep, and holding approximately 5,000 bushels. The *Boy*, the name given to this particular barge, was a small flat about the size of the fuel boat, housed in, and contained stock for the company's stores at the mines.

Three other pieces were picked up on the way, and we arrived at Point Pleasant, which is at the mouth of the Great Kanawha, with thirty-five, including the steamer. Fog and wind were here met with, and it was surprising to note the effect that little wind, apparently, had on the mass of "lumber"—empty barges. On account of the wind, it was necessary to land one-half of the tow on the Ohio bank and double up in order to enter the mouth of the smaller river. The passing of a packet is dreaded by the pilot of the towboat, on account of the heavy swells produced, especially on the smaller rivers. We had one experience of this on the Kanawha, where it was necessary to stop the wheel and float for fully one-half hour before it was safe to go ahead. The swells are sufficient to break up the tow, for they are, as termed by these river people, "whip-crackers."

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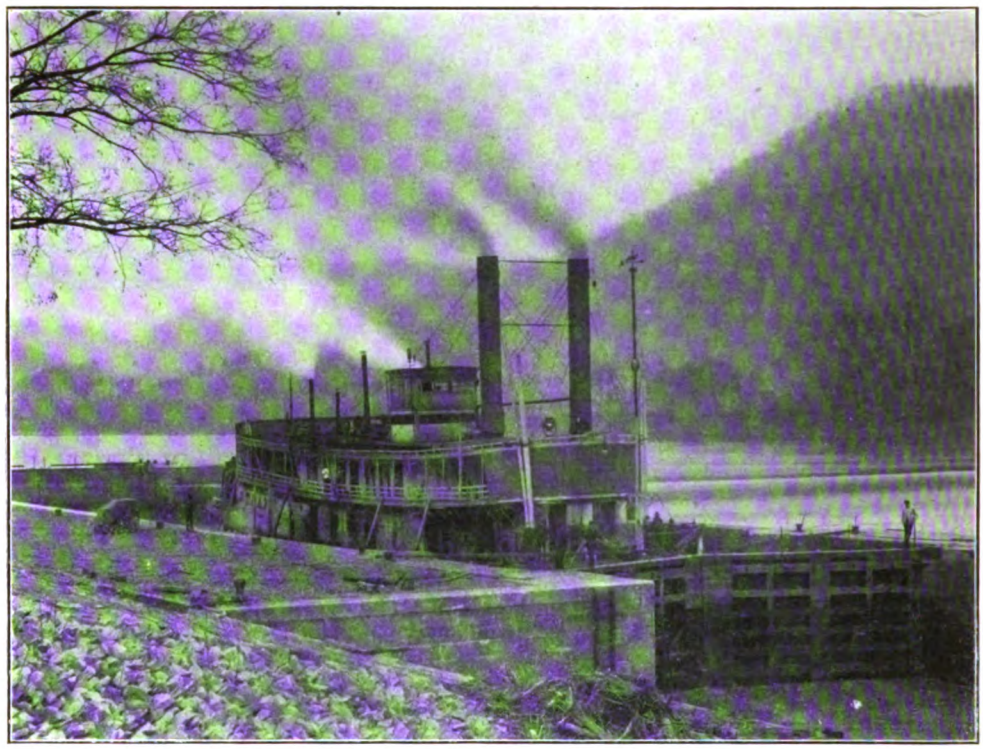
The method of towing on the western American rivers differs from all others, in that the tow is pushed instead of pulled.

Doubling up outside the point, we landed the tow of empties in two sections in the upper harbor about two miles above the mouth, and, dropping back one-half mile to the fleet of loaded pieces on the Henderson side, we laid up for over a week on account of the high water. A view of the Kanawha, looking toward the Ohio, is here given; it was taken from the railway bridge and shows the tow in the foreground on the Henderson side of the river, and the town of Point Pleasant in the background with dry-docks, landing, and general shipping.

During the time that the boat laid up, I made a trip on the *D. T. Lane*, referred to in the April number of MARINE ENGINEERING, to Mt. Carbon, which is at the head of the navigation on the Kanawha, 91 miles from the mouth. The trip was made in four days and every moment was of interest. Naturally the nights were not adapted to observation, but the clever pilot supplied this deficiency in great measure. This river is a tortuous stream, mostly of a rocky bed, and with many shoal places. To overcome these latter the government has constructed a system of dug chutes, and locks, and dams. The dug chutes are formed simply by dredging the channel; the material taken out, being mostly of rock, is dumped on either or both sides. There are no special forms for making chutes; they are built in accord with the needs of navigation. Some are as much as 1,500 or 2,000 feet long, and often are made in extremely sharp bends of the river. On this trip, as the chutes were entirely covered by the high water, in two instances a narrow line of willows was pointed out as the line, the trees seemingly growing out of the water. It was very clear that the pilot needed to be intimately acquainted with his river in all its stages, as well as with the unwieldy mass in front of him.

At Mt. Carbon, where the river is narrow and the hills are high, the banks on both sides are lined for miles with hundreds of coke ovens, which emit great volumes of smoke and fire, and when seen in the darkness through a heavy atmosphere are most striking. The coal is brought from the mines, which in some cases are six miles away, in small cars holding about 60 or 70 bushels. Along the river banks are several "tipples" for dumping the coal from the cars into the empty barges or pieces. These tipples are small wooden structures built on trestles well out over low-water mark, but on a level above any probable high water. The cars are run into the tipple house and the coal unloaded into a V-shaped box. An endless chain with buckets scrapes the coal from the box upon screens of different size openings, which sort the coal out according to size, from lump to slack. As it falls through the screens it is caught in hoppers or sliding bins which lower and discharge it to the barges below. It takes from five to nine hours to load a barge, and a tipple can handle about 1,500 tons a day. Some are made to load into either cars or barges.



STEAMER D. T. LANE LOCKING THROUGH ON THE KANAWHA RIVER.

Returning down the river, we passed through locks Nos. 2 and 3 by daylight; the picture of No. 3, showing the *Lane* locking through, was taken at 6.30 A.M. The locks are the same in general as the old-fashioned canal locks, except that they are more substantial. The lock-pit, or chamber, is built of stone, the walls 6 feet wide, and with room enough to admit two barges and the

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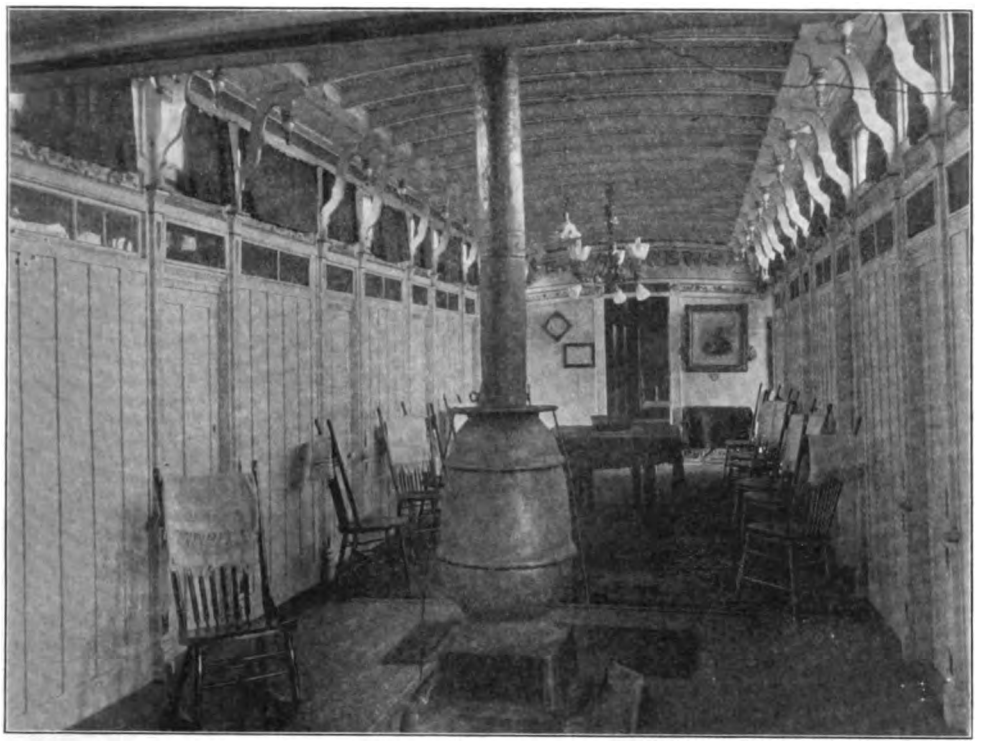
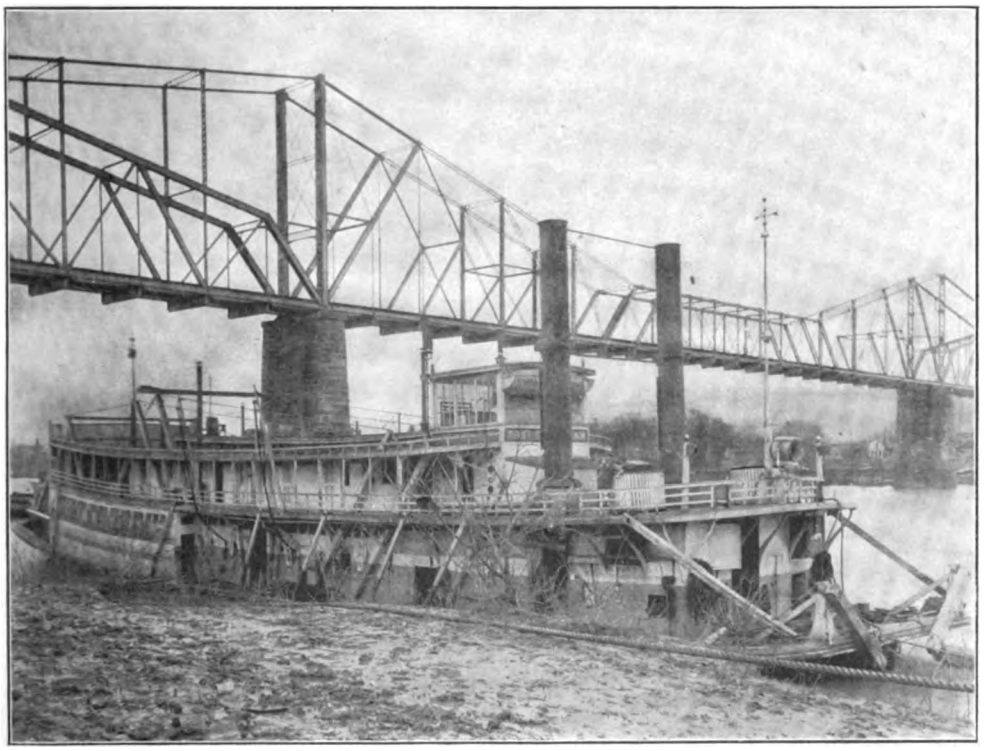


CABIN, LOOKING AFT, OHIO RIVER TOWBOAT.



THE ROBT. P. GILHAM, ONE OF THE COAL FLEET TOWBOATS.

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steamboat at a time, or four barges two abreast. The dams of Nos. 2 and 3 are what are termed fixed dams; all others on this river are movable. The fixed dam is simply a stone wall extending from the outer lock wall to the abutment on the opposite shore, the face of the wall slanting down stream. The lock is the same as in all the others; there is no "navigable pass," as the lock is used at all times, excepting in extremely high water when the level of the water over the dam is deep enough for boats to pass over.

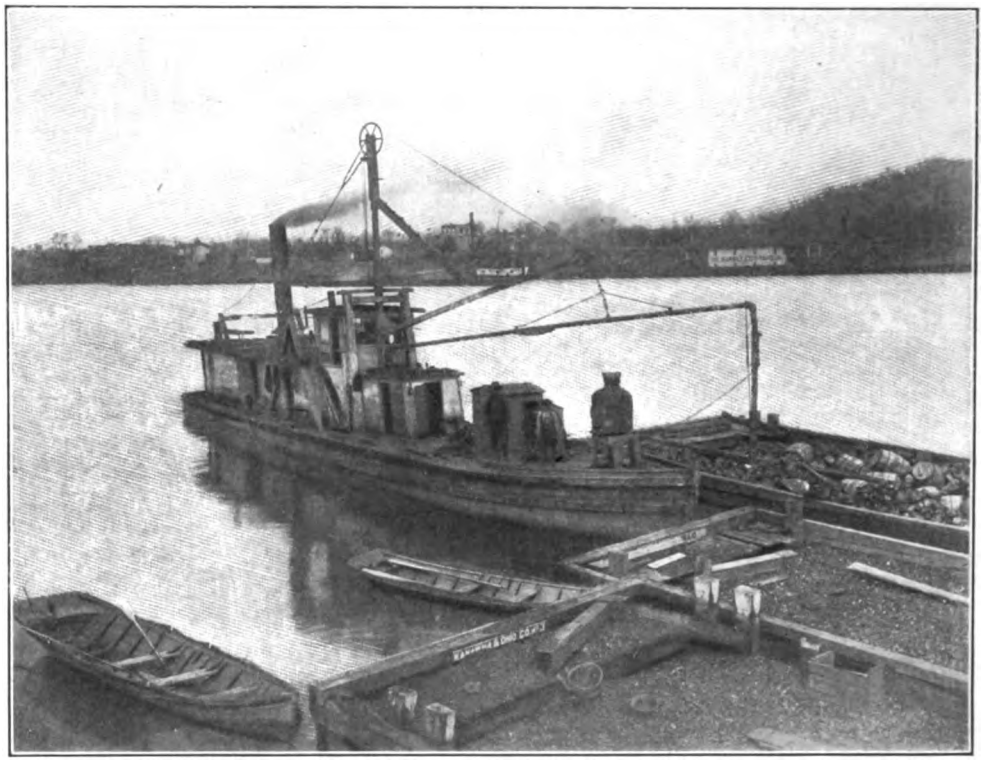
There are ten dams altogether between Mt. Carbon and the mouth of the river, No. 11 being the last one built, about three miles above Point Pleasant, and No. 1 having been contemplated, but either abandoned or left for some indefinite future time. The lock is built close to the shore, and beyond the outer lock wall is the navigable pass, which is a space wide and deep enough for boats and tows to go through in certain high stages of water. A pier extends from the pass to an abutment which sustains the weir or dam proper. In times of low water the fall over the dam is from 16 to 20 feet.

The movable dams are constructed so that the gates or wickets can be lowered to a level with the bed of the stream, and are always let down in seasons of high water, which sometimes is so great that boats and tows use the stream its full width. The illustration of lock 11 which is herewith presented shows the dam in course of construction, the lock walls and chamber completed, and the pass and the weir as they appear when up.

The weir gates are held in place by a series of pivoted angle props or braces. These props are raised by a chain and windlass which runs on a track laid in sections on the top of the props as they are drawn in place. After the props are swung up, the winch raises the gates, which operate practically like a book when laid open face down on the table and raised from the back.

In locking through with a towboat going down stream, the steamboat pushes four of the barges, two abreast, into the pit, casts away, and backs out. The upper gates are closed and the valves in the lower gates are opened by a winch to allow the water to escape, thus leaving the vessels on the level of the stream below, and the upper gates holding back the water above. The gates are opened and shut by two goose-neck levers which swing into recesses flush with the sides of the chamber. When the lower gates have been opened, the barges are floated out and landed at some convenient place below, and in turn all the other pieces are locked through in this manner. The steamboat, which is the last to go through, must reassemble the tow with about the same labor that is required in hitching-up at the harbor. This tedious operation must be repeated, of course, at each of the locks. The illustration of the *Lane* going down stream shows in part the rip-rap-made shore, the lock wheels, the gates and dam. The waterfall over the dam was not more than 3 or 4 feet, and scarcely shows as it might in times of low water.

In low water, to save time and labor in locking through, the tows are made up two abreast without the pool and bearing is made direct from the head of the boat to other barges or fuel flat. The tow, stern, and bridle lines are placed in this arrangement the same as in the large river tows, and the formation avoids the necessity of breaking up in locking through.



STEAM PUMP BOAT, WITH SUCTION PUMP CONNECTED TO BARGE.

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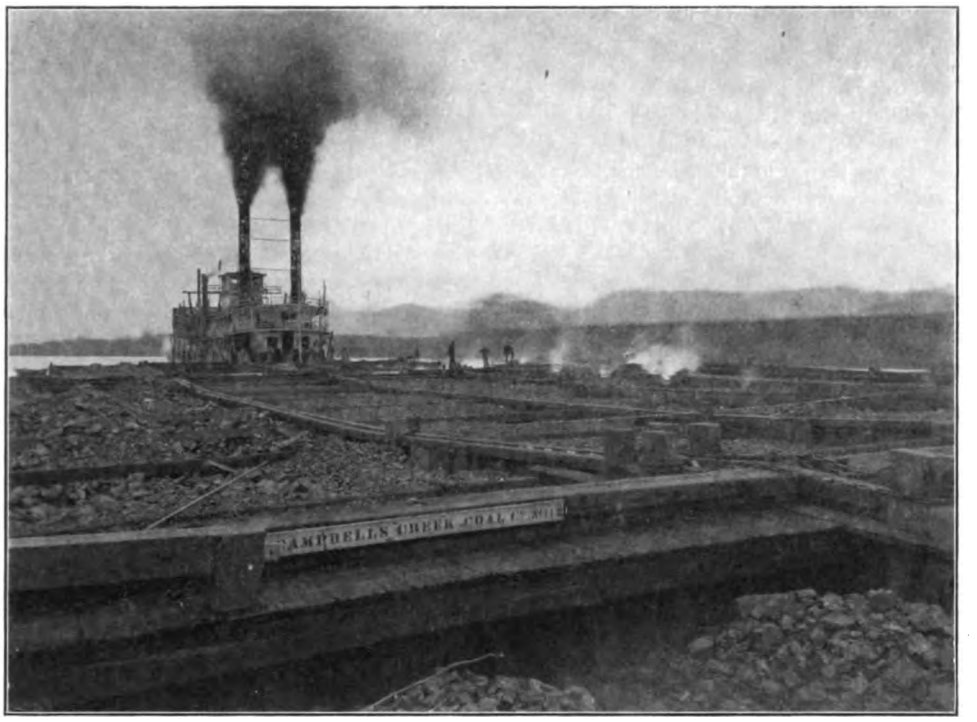
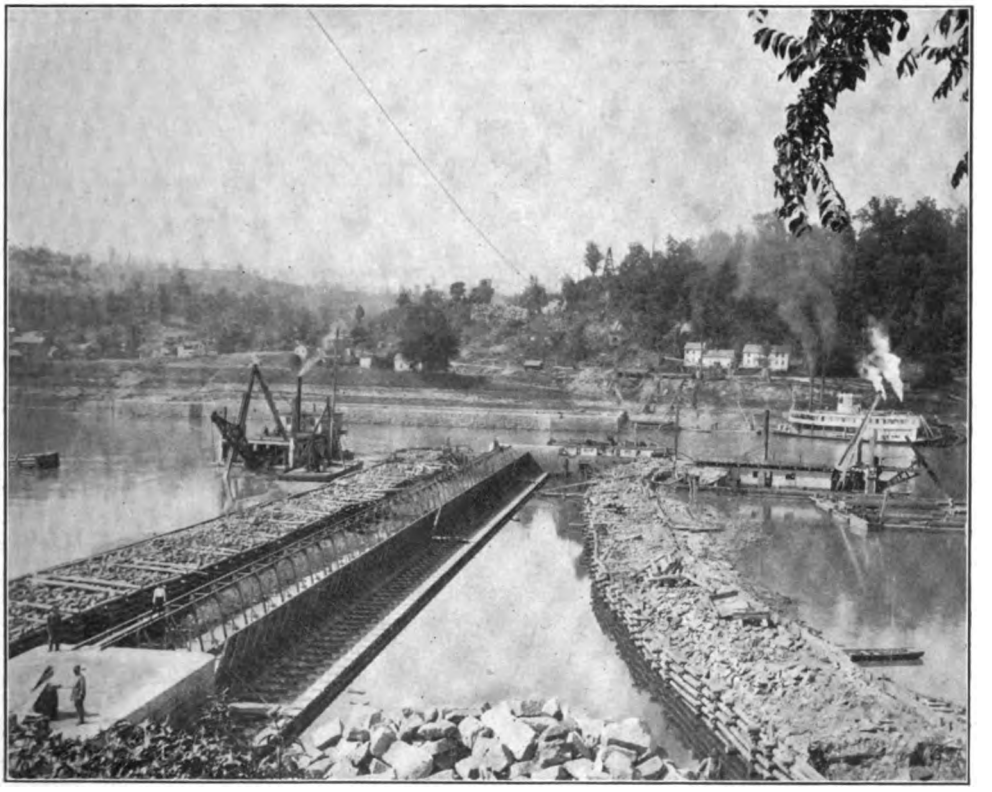


STEAMING DOWN THE KANAWHA—VIEW FROM THE HEAD OF THE TOW, SHOWING LINES OF STEAM SIPHONS.



BUILDING LOCK NO. 11, KANAWHA RIVER.

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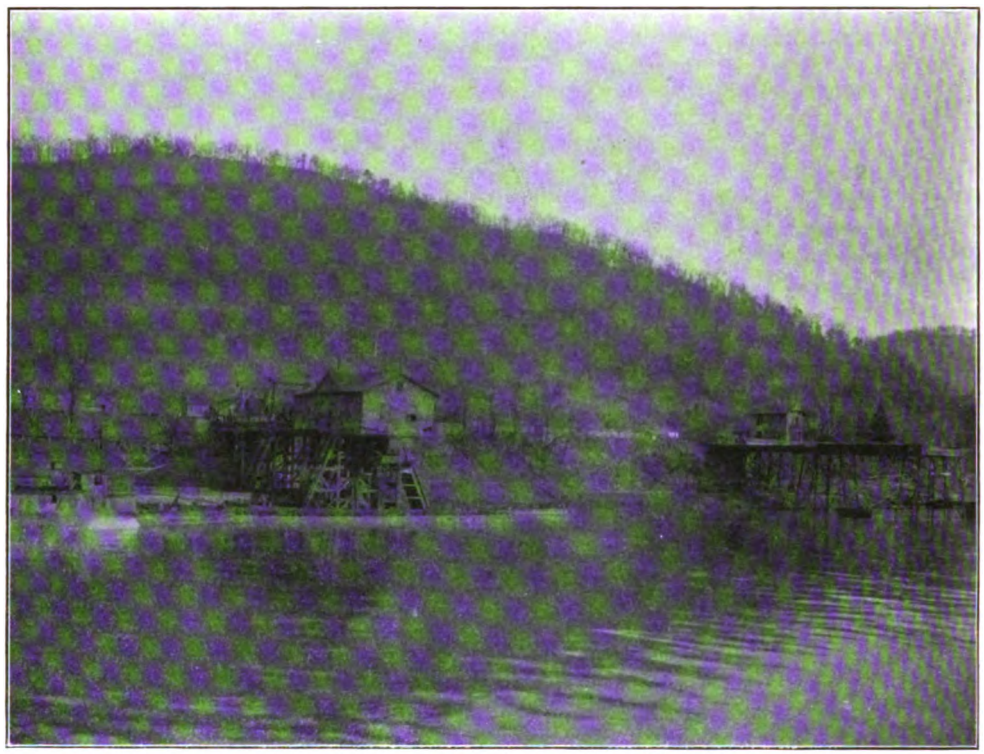
The barges are built to some extent by the coal companies in rough yards on the edge of the river bank. When completed a barge is skidded on to a wooden track (ways) inclining into the water, and is "let go" broadside to the river. The barge is positive in its demand for water outside, while continual work is required, maybe, to keep the water from the insides. The steam siphons used for this work are shown in the engraving, page 301. Steam is carried in pipes the full length of the tow, whether 150 or 700 feet, and, as they are gluttons for steam, and often rob the boat of her supply, the boilers must be of ample capacity to perform the duty of this double service. The pump boxes are of wood, four or six in number, placed on both sides of the barge, measuring about 18 by 30 inches, and extending to within a few inches from the bottom. There is always some water in the boats, and when it reaches 8 to 12 inches pumping begins. Another means of clearing the water is by use of the funnel, which is a galvanized iron tube 18 inches long, 3 inches diameter at the top, tapering to 2 inches. This is driven through a plank in the bottom of the barge, large end upward, until it approaches only 3 or 4 inches above the plank. A rubber hose is fitted on the small end of the funnel and a hole bored through a plank in the bottom of the barge. The small end is put in first and the funnel down until only 2 or 3 inches are left above the plank. When the barge is in motion, the rubber hose will naturally turn toward the stern and the suction will draw whatever water is in the barge down through the funnel and out. But no one of these processes can keep the barges dry. Each barge carries its hand pump, which consists of a wooden square box with a spout, leather valve, and rod operated by two men either by direct lift and push on the plunger rod or by a long stick spring lever.

In the harbors the pump boats are used, one a steamboat, and the other a flatboat. The first is equipped with a steam propeller and is sometimes even used in harbor towing, while the other is dependent on some outside source for propulsion, but has a steam capstan. It is, however, the more common of the two. These pump boats are equipped to use either the suction or siphon, singly or together. A pipe for the suction pump is carried on a crane extending over the bow of the boat, long enough to reach across the width of a barge on either side, thus giving access to a fleet four wide. In the view of the fleet on page 297 this flatboat is seen in the open-water passage, or pool, at the center of the tow. A large fleet, such as ours, requires two pump boats, one in the center and the other on the outside. These boats are also used to spar the fleet away from the bank in falling water. A spar is placed against the bank and a line attached to the other end is led to the steam capstan, and by this means the boat is pushed from the shore.



TIPPLE FOR LOADING COAL AT CAMPBELL CREEK ON THE KANAWHA.

One feature of river towing which is an evidence of activity is the portable telephone outfit which the boat is supplied with. From a permanent pole on the bank, which carries a telephone wire, connection is made, as soon as the boat lays up at terminal, to a wire on a windlass on board, hung against the inside of the "roof" forward of the cabin bulkhead, and connected up to the instrument in the cabin. A wire runs over a pole to take up the slack when the water is rising and to let out when

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the water is falling. By the use of these stations the steamboat is at all times connected with local and long-distance telephone lines, except when under way. At different points en route mail matter was sent ashore and collected by the yawl.

After a week's delay at Point Pleasant, on account of high water, the captain finally gave the order to "hitch up" and make ready to leave for Cincinnati as soon as possible. The news was indeed welcome. When the work of heading up was started, the steamboat cut loose from the harbor fleet and began a selection of the particular pieces which she must take down the river. These are drawn from the fleet, one, two, or three at a time, and, in the meantime, the lashing ratchets, chains, and lines are distributed to the pieces which are to be taken, for the lines and lashings on the fleet belong to the harbor and must be exchanged for the boat's lines. The smaller craft, usually the fuel flats, are selected first, and form the pool. These are landed at a convenient spot and one-half of the crew stay with the tow while it is being made up, and the balance remain with the boat, which returns to the fleet for more pieces. As fast as two or three are swung into position, the men on the tow lash up and ratchet them, so that when the last pieces are brought up and placed, the tow is practically completed. The work of necessity requires much time, as often the barges needed are at the inside of the fleet. There is plenty of hard work for the entire crew, from the captain down, in making up a tow. When all is completed, the steamboat swings out into the stream, takes her place at the foot of the pool, the shore lines are cast off, and, backing out into the stream, the steamer is ready for the start. Then the crew resume their watches and those on watch nail the splash boards to the outside edges of the outer barges. These are rough boards 12 inches wide and are used to keep the waves, stirred up by wind or passing boats, from sweeping over the sides or heads of the barges. The trip down the Ohio was completed without further incident.

Explosion of a Gasoline Yacht.

The yacht *Vagabond,* propelled by gasoline and equipped with an acetylene lighting plant, blew up on May 16 in the East river, New York. The owner, Mrs. J. B. Gibson, and several of the crew were more or less burned.

The exact cause of the accident is not given out, but it appears that the gasoline fumes were exploded by the acetylene lighting plant. When one of the gas jets was lighted in the cabin an explosion of gasoline followed. The yacht had been prepared for a summer cruise and there was much valuable property of the owner on board. After the explosion the vessel took fire and sank at her moorings.

The Largest Freighter of the Lakes.—A vessel of 500 feet length over all, 480 feet keel, 52 feet beam, and 30 feet depth has been contracted for by Cleveland parties with the Columbia Iron Works, St. Clair, Mich. The vessel will be longer by two feet than the four largest ships built by the American Shipbuilding Company. It is stated that Mr. M. A. Bradley closed the contract for the vessel.

SIMPLE METHODS OF TESTING OILS.

BY J. K. NYE.

A short time ago the writer in an idle moment evolved a rambling article on the subject of "Lubrication," which this worthy journal took in hand and published. It brought forth a letter from a marine engineer whose high standing in his profession proves very conclusively what the writer in his humble way tried to prove: that nearly all the oil purchased by marine or any other engineer was bought purely upon the assertion of the smooth-tongued drummer, and not because said engineer had any knowledge of the physical qualities of his lubricant. Of course no engineer can go very deeply into the chemical testing of his oil; but he can a little, and he can get the all-sufficient information by mechanical methods.

Three things he can easily learn to determine: viscosity, gravity, and fire test, and we will deal with them separately.

VISCOSITY.

The first is perhaps the hardest, because all viscosity of oils, whether put out by the Standard Oil Company or other makers, is based upon an arbitrary standard, so that any viscosity test which is made in a rough way can only be made *relatively.* At any chemical warehouse can be purchased what is known as a pipette, which we herewith show in Fig. 1, consisting of a simple glass tube with a bulb blown in the center; the lower end of the tube is drawn to a tiny point and above the bulb is marked a ring on the glass. The operation of the instrument is as follows: The oil is drawn into the tube by suction of the mouth up to the ring. A finger is placed over the top, preventing the escape of oil, and holding the watch in one hand, the tube in the other, the finger is suddenly lifted off and the oil is allowed to flow out, the time of such flow being taken. The number of seconds required can be the engineer's standard of viscosity; that is, having taken a sample of oil which suits him, he places it in some position where it can be heated to a convenient temperature, say 70 degrees Fahrenheit. After he is sure of his temperature he fills his tube as above described and allows it to run away, and makes a memorandum of the number of seconds. The same performance must be gone through with every oil which he wishes to test. If it runs out in a less number of seconds the viscosity will be known to be less than his standard; if it takes more time it is greater than his standard. As I said above, this is a relative test, but a little practice will be a great education for an engineer in connection with the other test to follow, and if persistent he will soon become proficient in judging the *relative* viscosity values of his oil.

Now, right here it may be well to poke around a bit in what is called "molecular construction." In a previous article I referred to the little microscopic pits which even the finest turned bearing or cylinder is bound to contain, and there tried to show their relation to lubrication. This same condition exists in oils also, although in their case the "molecular construction" is far beyond the power of the microscope to show, so that while the engineer is performing the above viscosity test let him try to conceive the oil being composed

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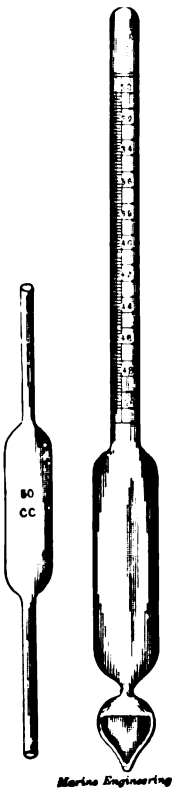
of tiny little globules or balls of lubricating matter. He can readily see that the rate at which they crowd out of the tiny hole at the bottom of the pipette will be largely due to their size. There even might be imaginable such a thing as one molecule too large to come out at all if the hole were fine enough.

Now, having conceived of this pipette full of little balls of lubricating matter which are running like the sands out of an hour-glass, there will be shown another feature connected with them, and which would regulate the speed of flow independently of the size of the molecule, namely, the phenomenon which a scientist would call "surface tension," but which we will term "the difficulty which one of the molecules or balls experiences in trying to pull away from its next neighbor."

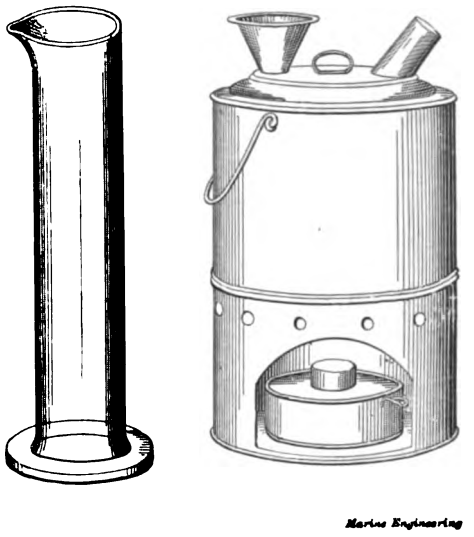


FIGS. 1 AND 2.

As an illustration, let the engineer take a piece of very fine wire, bend the end into a loop, say a quarter of an inch in diameter; if he dips this into a little soapy water he can pick up a film of fluid, which will extend clear across the loop, and which, being blown upon, he will find really has considerable strength. Various liquids (most oils included) will make such a film, and, while it generally varies with the viscosity, seeming to have considerable relation to it, it is also strong proof that the molecules of some kinds of liquid have a stronger affinity for each other than others, and if this is so it is plain to our minds that in crowding out of the tiny hole in the pipette some liquids must cling together with more strength than others and thus retard the flow. If this is the case, oil between two moving surfaces of metal must operate much in the same way. Heat reduces viscosity and also reduces this "surface tension," so that an engineer in studying his relative viscosity of a cylinder oil must take into consideration the heat of his steam, and, other tests being satisfactory, choose that oil which will give him the best film effect for his particular steam temperature and piston speed.

SPECIFIC GRAVITY.

The next test should be for gravity. The specific gravity of any substance, solid or liquid, is its weight compared with an equal volume of water; and while again it is impossible for the engineer to go into the determination of absolute gravities, since the gravity of all oils is based upon an arbitrary standard, it is easy enough for him to get close to the true gravity of the mineral oil by means of a little instrument called a hydrometer, Fig. 2, which costs but a very few cents at any house selling chemical glassware. He will need a long test glass, say 12 or 14 inches high, 2 inches in diameter, such as shown in Fig. 3, and which is also a



FIGS. 3 AND 4.

cheap affair, for sale at a chemical glassware house. Into this he pours his sample of oil to be tested and then floats the hydrometer. In the tube of the hydrometer is marked a scale, which just simply floats higher or lower as the liquid may be lighter or heavier in gravity. Of course here again the temperature must be carefully taken, and all tests of samples must of course be made at the same temperature, the best and most convenient being at 70 degrees. Any temperature can, of course, be selected which is most convenient for the operator, and it is best always to consider these tests relatively, that is, one *known* sample against sample on trial.

FIRE TEST.

The third lubrication test which it is possible for the engineer to make is the fire test. All are thoroughly familiar with the term—for what engineer has not had to stand before the drummer and either laughed or cursed at his endless harangue over this self-same "fire test"?—and it all means simply this: Any oil, if sufficiently heated, will give off a vapor at a certain temperature. This vapor rises slowly, and upon the application of a tiny flame the mixture of such vapor with the air on the

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surface of the heated oil ignites and burns with a momentary flash. This is termed the flash point. If the temperature be increased the amount of vapor increases until it becomes rapid enough to support a tiny flame. At this point is the fire test, the drummer's trump card.

Now, for the determination of this fire test the engineer needs only a simple apparatus, which he can buy or easily make. It consists of a little metal standard shaped something like a petticoat, under which an alcohol lamp can be placed, and on the top a shallow dish to hold the oil to be heated. This should be about 2 inches in diameter and an inch deep. The whole thing is shown in Fig. 4. In addition to this the experimenter will need a thermometer registering up to, say, 800 degrees, which can be purchased at any supply house, and it should be supported so that the bulb hangs well covered by the oil in the little pan. As the temperature slowly rises the engineer should provide himself with a number of wooden toothpicks shaved down to the tiniest point. When the thermometer has risen to the point at which a test should be made, light the end of a toothpick, making the smallest possible flame, and pass it quickly over the oil. If a flash or burn, as before stated, occurs, this will be all the engineer cares to know.

With the above-named outfit or apparatus, a little perseverance and experiment, any user of oil will gather in a goodly store of useful knowledge. He will eventually arrive at the point where a brand of oil will mean very little to him. He will be able to ask his dealer for an oil of a certain gravity, viscosity, and fire test. He will be able to examine such oil and prove for himself whether he gets requirements or not. As I have before stated, if this practice was general among engineers and buyers of oil, all brands would in time disappear from the market—a state of affairs which would save untold thousands of dollars to users of machinery, and it is the writer's hope that some of them may think it worth while to take up this rough line of experiment.

As an interesting line of thought for an engineer to follow while carrying on these experiments, perhaps a few words on oil in general may not be out of order. Almost all oils possess, in a greater or less degree, ability to evaporate; this more particularly in the case of hydrocarbon or mineral oils, while the fixed oils, oils made from animal or vegetable matter, possess it in a very small degree. If a straight hydrocarbon oil be used where the heat is high, as in a steam cylinder, it would in time completely evaporate. This is a very proper condition if the time is not too long. In order to counteract this tendency to evaporate, some dealers use animal oil in mixture with hydrocarbon for use in steam cylinders, but any mixture of animal oil does not prevent the hydrocarbon from evaporating first, leaving the fixed oil to gradually decompose under the heat. Most oil dealers tell the engineer that the high fire test overcomes this; but it will be an interesting experiment for the engineer to take a small quantity of this oil, place it in a concave piece of glass (a heavy watch crystal will do), let it lie for a long time on a cylinder head or in some place where it will be subjected to the temperature of the steam, and he will see that, no matter how high its fire test, the oil will gradually lessen in quantity. If animal oil has been mixed with it, it will in time leave a thick residue, or even pass to the solid state.

Finishing I wish to repeat that the above tests are simple methods and only relative. There are many more which are really within the scope of the average engineer, and, having familiarized himself with these, others will suggest themselves; but simple as they are, if adopted by steam engineers in general, the purchase of oil would be based upon its usefulness for specific cases. Brands would disappear, and one would buy his lubricants as he now buys his tea or sugar or coffee or flour.

Mosley Industrial Commission.

The report of the Mosley Industrial Commission has just been issued, forming a voluminous publication of some 280 pages, containing the reports of twenty-three contributors. It will be remembered that Mr. A. Mosley, an Englishman, offered to pay the expenses of representatives of the different English trades on a tour of inspection to the United States for the purpose of visiting our great industrial establishments, to learn of the conditions surrounding the workmen in this country, and if there were any causes apparent for the superiority of American methods of manufacture. Mr. Mosley has traveled extensively, and, while in the United States, he was impressed with the better condition of American workmen, and that as a manufacturing country America was forging ahead at a pace hardly realized by either British employers or workmen.

Before leaving England Mr. Mosley gave to each of the twenty-two members, each of whom was selected from a trade union, a list of questions which he requested them to answer as far as possible. These were forty-one in number and dealt with the early training of the workmen, the relations between employer and employee, and general conditions of workers outside the factory. While in many cases the answers are, as might be expected, contradictory, the general report of the delegates is in agreement. It is well to have the side of the laborer presented, but Mr. Mosley's own report is of far greater value, as it comes from a thoroughly-educated and broad-minded man who has the interests of his country at heart. Mr. Mosley's claim is that the "true-born American is a better-educated, better-housed, better-fed, and better-clothed and more energetic man than his British brother, and infinitely more sober; as a natural consequence he is more capable of using his brains as well as his hands." The reports of the delegates in general bear out this view, although there are, of course, some exceptions—as for instance, one delegate considers the American workmen are too well fed. On the question of drinking all are practically agreed with Mr. Mosley's statement as above expressed. Also all practically agree that the American workman has a sounder education, largely due to the fact that in the public schools the rich meet with the poor and give to them a certain culture, and, at the same time, both are benefited by knowing personally some of the other class. This acquaintance educates a man in the knowledge of how to get along with others, and it is invaluable in later life.

Concerning the relations of employer to employee, Mr. Mosley states: "In England it has been the rule

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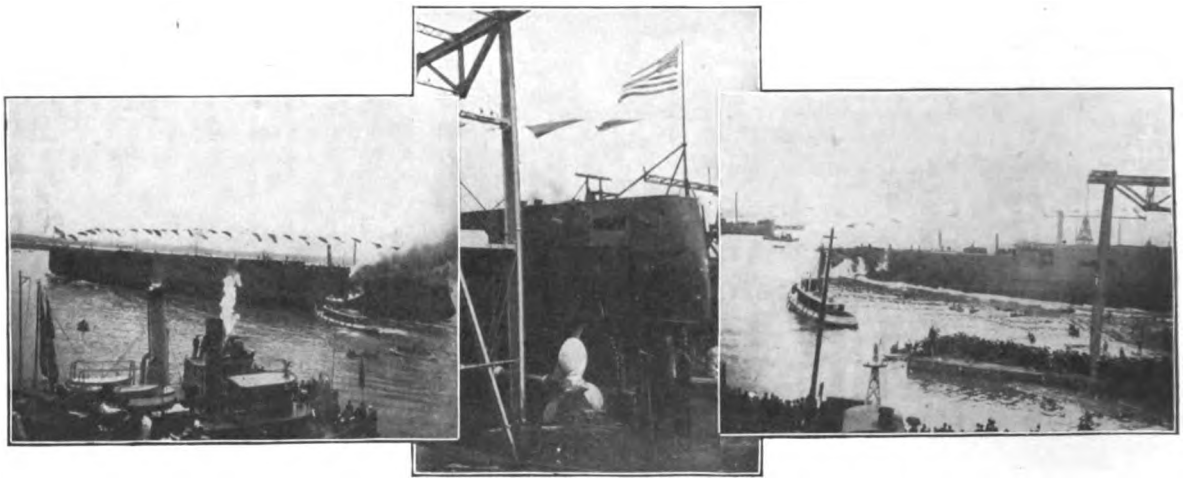
for generations past that as soon as a man earns beyond a certain amount of wages the price for his work is cut down, and he, finding that working harder or running his machine quicker brings in the long run no larger reward, slackens his efforts accordingly. If this is to be the case can we blame the workman?" We are sorry to state that this custom is not unknown in our own country, but British manufacturers are already realizing their mistake in adopting this plan.

Most of the delegates were surprised to find that Americans did not work so extremely hard or long as was supposed; while their hours are longer than in England they are much better paid and make good use of their leisure. On the whole the opinion appears to be that the American is better off than the Briton, when considered from the point of expense and wages, by about from 20 to 25 per cent. The use of labor-saving machinery, the delegates believe, is one of the most important reasons for the progress in this country, which we Americans fully realize.

While the report does not confirm the rash statements of the daily press on both sides of the Atlantic as to the superiority of the United States in all lines of manufacture, it does indicate in what lines our success is gained. What better comparison of the condition of labor in the two countries can be had than by the fact that so many English and Scotch artisans are to be found here in this country? They come to us well trained in their professions and here they are given the opportunity to progress, and apparently make the best use of such opportunity, for they are to be found in positions of importance. One of the greatest differences, as pointed out in the report, is in the attitude of the manufacturers toward their men. Successful Americans have frankly acknowledged that a great part of their success, if not the greatest, has been in finding capable men to fill responsible positions, and that they are constantly on the lookout for *brains*.

LAUNCHES.

U. S. S. Colorado.—On April 25 the armored cruiser *Colorado* was successfully launched from the William Cramp and Sons' Ship and Engine Building Company's shipyard. The ship is 502 feet on the water line, 69 feet 6 1-2 inches extreme beam, and, when fully equipped and ready for sea, is to have a mean draft of 24 feet 1 inch and a displacement of 13,680 tons. She is to be driven by twin-screw, triple-expansion engines at a speed of 22 knots for four consecutive hours. Niclausse boilers are installed. The ship has two 8-inch barbette turrets, one forward and one aft, and two military masts. The armor is made by the latest improved Krupp process and consists of a water-line belt 6 inches amidships and 3 1-2 inches at the ends; barbettes of 6-inch armor and turrets 6 and 6 1-2 inches thick. In each turret are mounted two 8-inch B. L. R. guns, and in the superstructure on the gun deck are fourteen 6-inch R. F. guns; these are mounted behind 5-inch armor and a belt of cellulose extends from stem to stern above the protective deck. The secondary battery consists of eighteen 3-inch R. F. guns, twelve 3-pounder R. F., eight 1-pounder R. F., two 3-inch R. F. field pieces, two machine guns, and six automatic guns. The 8-inch guns are designed to fire once every fifty seconds and the 6-inch guns once in twenty seconds. The contract price for the *Colorado is* $3,780,000.



VIEWS TAKEN AT THE LAUNCHING OF THE U. S. CRUISER COLORADO FROM MESSRS. CRAMP'S SHIPYARD.

Steam Yacht Haouli.—The steam yacht *Haouli* was launched recently at Erie Basin Dry-Dock, Brooklyn, N. Y., built from plans of Mr. Henry J. Gielow. The yacht is for Mr. S. M. Smith, of San Francisco, and is 211 feet 3 inches over all, 106 feet on the water line, 21 feet 6 inches beam, and her draft will be 9 feet. Four-cylinder, triple-expansion engines, designed to indicate about 1,800 horse power, will be furnished with steam by four water-tube boilers. The vessel is very handsomely fitted out for long cruises.

Steam Yacht Czarina.—A fine single-screw steam yacht was launched on April 4 from the Crescent Shipyard, Elizabeth, N. J., and christened the *Czarina*. The principal dimensions of the vessel are: Length over all, 172 feet; on water line, 140 feet; breadth, molded, 22 feet; depth, molded, 12 feet 6 inches; draft, 9 feet 6 inches; displacement, about 300 tons. A description of this yacht will be presented in a later number of MARINE ENGINEERING.

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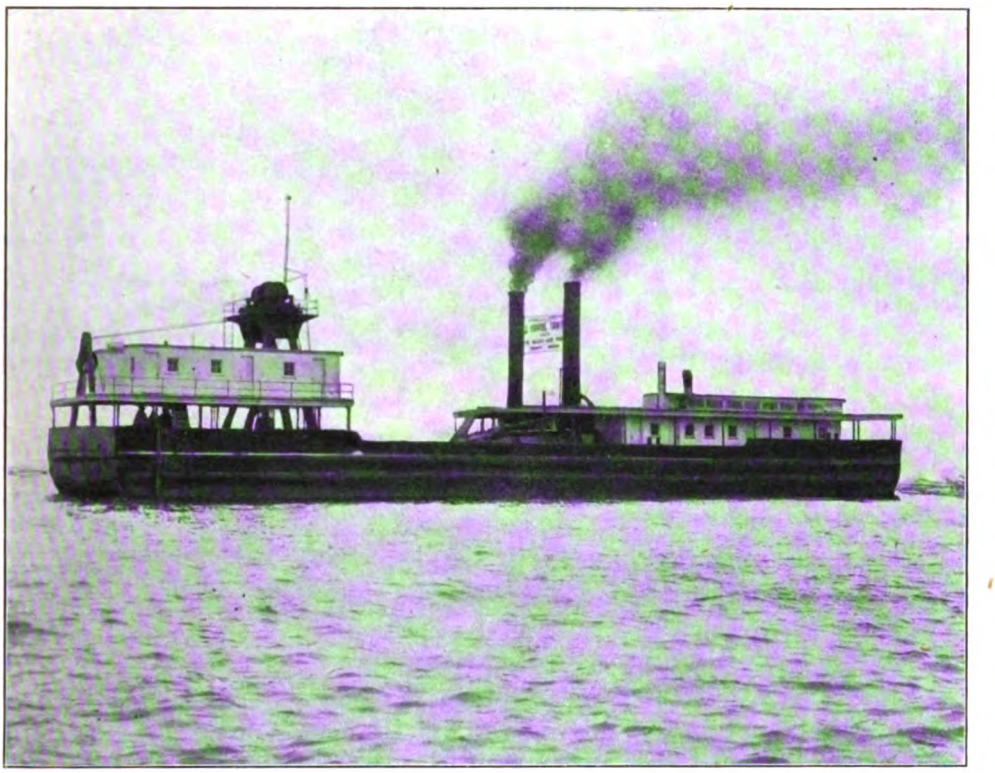
CANADIAN-BUILT HYDRAULIC DREDGE.

There are abundant indications that a great wave of commercial prosperity has commenced to roll over Canada, coincident with the dawn of the new century. There is no boom, but a steady onward progress of increasing volume and momentum, showing that the men of the northern zone, whilst realizing and appreciating fully the well-known maxim *Festina lente*, are beginning in earnest to develop the immense possibilities of that land wherein Nature has been and is so bountiful with her gifts.

Canadians are alert, energetic, and intelligent, prone to be cautious rather than over-sanguine, and, with such characteristics, they can be relied upon to build up their young country upon the solid rock of sound commercial principles. They are justified in looking forward with a spirit of hopeful confidence to the future development of their country, because the possibilities of the Great Northwest, the satisfactory condition of general business throughout the Dominion, the high price of Canadian securities upon the London Stock Exchange, the immense influx of immigrants from the United States and Great Britain—all of them being of a superior class, many comparatively wealthy—the scarcity of labor, the upward trend of wages, the growth of manufacturing industries, have at last, apparently, penetrated the highly-tempered steel armor of British exclusiveness and conservatism to such an extent as to induce a party of at least fifty members of the British Parliament to make a tour of the country and convince themselves whether the optimism of the Canadians is well founded or not. There is not much doubt but that the distinguished visitors will return, as did Queen Sheba of old, saying "the half had not been told them," with the result that, at any rate, a goodly portion of the stream of British gold which has hitherto been poured out so lavishly in Africa and elsewhere will become directed toward "Britain's foremost colony," to the manifest advantage of the investors as well as the colonist.

One of the evidences of this prosperity and progress is seen in the successful building of a modern steel hydraulic dredge, named the *J. Israel Tarte*, by the Polson Iron Works, Toronto, Ont., for the Dominion government. This vessel is one of the largest and most powerful dredges of its kind ever built, and represents the highest development of engineering in this direction. The hull is built of steel throughout, is 160 feet long, 42 feet beam, and 13 feet deep. It is constructed with an open well in the center 80 feet long, through which the huge suction pipe operates. This suction pipe is 40 inches square and is built in the form of a square box girder, having extended flanges of great width to resist the strains of coming in contact with the bottom. At the lower end of this suction pipe there is an immense cast-steel rotary cutter 9 feet 6 inches diameter and weighing 10 tons. The cutter is driven by a pair of double-tandem compound engines mounted on top of the girders at the upper end. These engines are of 300 I. H. P. and are of massive construction. The cutter is designed to excavate hard clay, or other difficult substance other than stones or rock, without difficulty. It is sufficiently strong that if any immovable resistance,



HYDRAULIC DREDGE J. ISRAEL TARTE.

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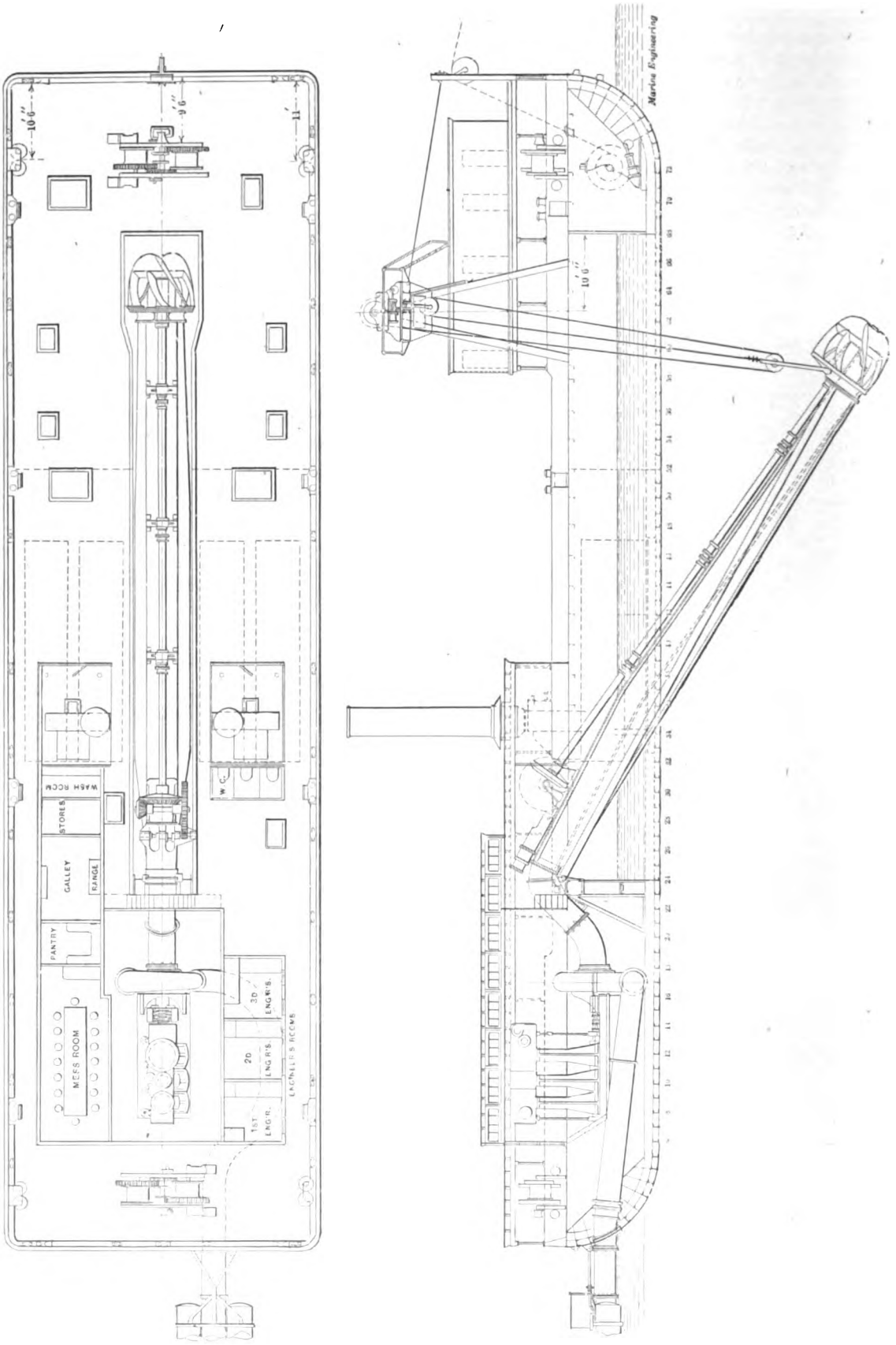

DECK PLAN AND INBOARD PROFILE OF THE HYDRAULIC DREDGE J. ISRAEL TARTE, BUILT AT THE POLSON IRON WORKS, TORONTO, ONTARIO, A. W. ROBINSON, CONSULTING ENGINEER.

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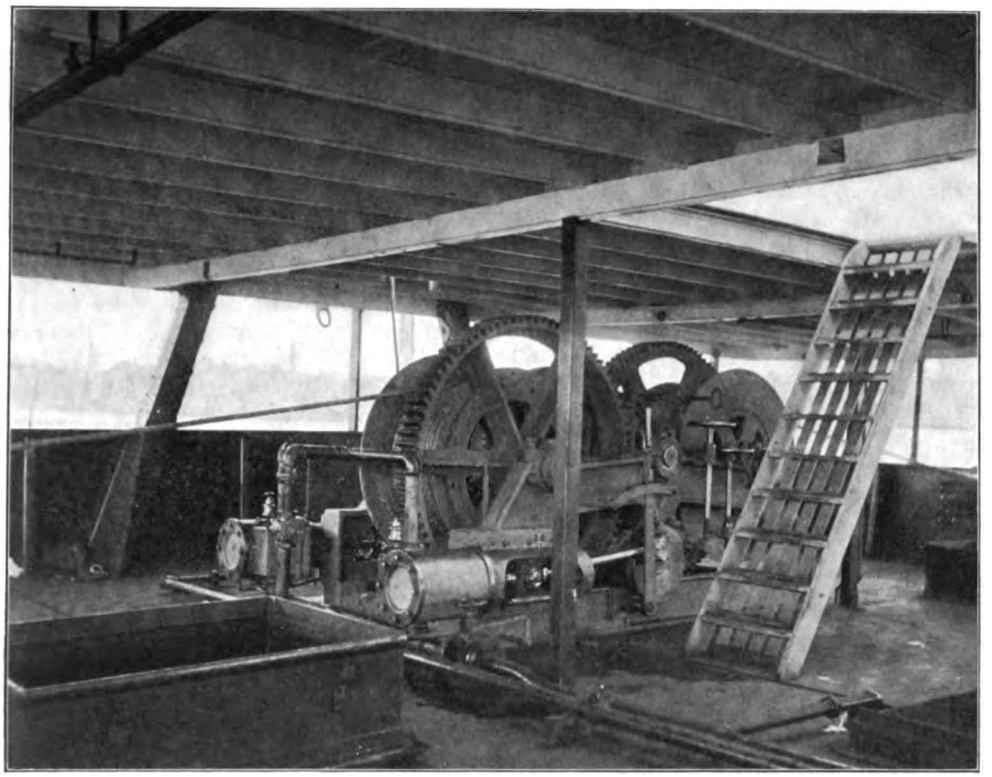
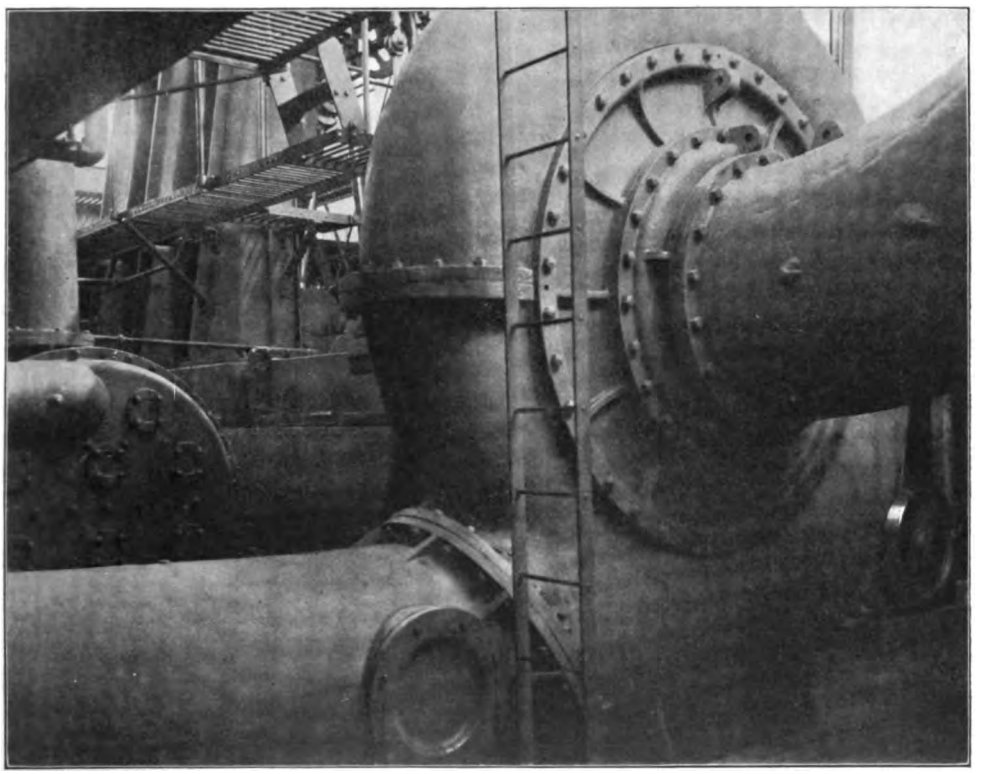


WINCH FOR CONTROLLING THE SUCTION ARM.



ENGINE ROOM AND MAIN SUCTION PUMP, HYDRAULIC DREDGE J. ISRAEL TARTE.

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such as rock, should be encountered no breakage will occur—the engines will simply stop, all the working parts being strong enough to stall the engines. The dredge is to be used for deepening the St. Lawrence river, where it will encounter nothing but sand.

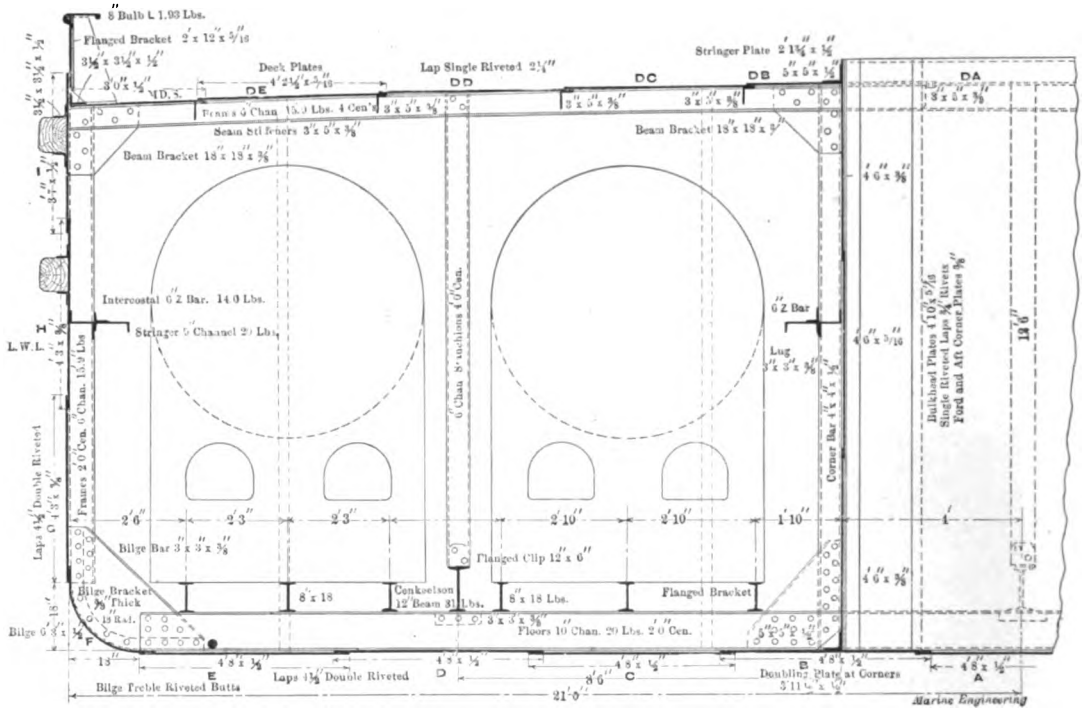
The great advantage of this type of dredge over any other for this work is that it transports and discharges all the dredged material at one operation without the use of scows or tugs with their attendant expense and interruption. In fact, it would be extremely difficult to provide sufficient scows and manipulate them fast enough to remove the large amount of material which this machine is capable of dredging. Its operation is continuous and uninterrupted, the material being discharged through a series of floating discharge pipes with flexible connections. These pipes are 36 inches diameter, and when coupled up form a line 2,000 feet long. The pipe and its two floats are built in sections 100 feet long, all of steel. The center one is the discharge pipe for carrying away the dredged material, and is supported by a water-tight air chamber or float on each side. The discharge end of the pipe is carried over a large scow, which is anchored in position where required, and is able to feed itself along, as the dredge progresses, by means of a steam winch.

The motive power consists of a set of triple-expansion engines having cylinders 20, 31, and 50 inches diameter by 25 inches stroke, of 1,200 H. P., which drive a large centrifugal pump. This pump is of special construction for the work, being designed for great efficiency and so that it will not clog even with large masses of solid matter. There are four boilers of the locomotive type, each 74 inches diameter, 31 feet long, having collectively 6,000 square feet of heating surface, built to pass government inspection for 160 pounds working pressure, and fitted with the Sturtevant system of induced draft automatically regulated by the steam pressure in the boilers.

The movements of the dredge are controlled by powerful steam winches at either end, by which the vessel is moved at any desired rate and under perfect control at any time. Commodious quarters for the officers and crew are provided both on the main and upper decks. There is a complete electric installation, so that the dredge can work night and day.

The full capacity of the plant is 10,000 cubic yards mixed material (sand and water) or 2,000 cubic yards solid matter per hour. This dredge is an entirely Canadian production. The Polson Iron Works not only built the hull, but also the main pump, triple-expansion engines, boilers, pontoons, and pipe connections, at a cost of over $250,000, and, in fact, handed the plant over complete and in full operation to the Minister of Public Works in Toronto bay. Since the vessel has been doing her work upon the channel of the St. Lawrence river, the company has received congratulatory reports of her behavior from the Deputy Minister of Public Works at Ottawa. Associated with the firm as consulting engineer for this vessel was Mr. A. W. Robinson, M.E., C.E., Montreal.

Owing to the steady increase of business, the Polson Iron Works recently increased the area of its premises by reclaiming an additional four acres of land from Toronto bay, thus obtaining altogether 2,100 feet of water frontage. At the same time the company rebuilt and re-equipped its wood-working and pattern-making shops, as well as the smithy, and these are fully up to date as regards machinery, heating, and lighting. The largest planing machine and boring mill



MIDSHIP SECTION OF CANADIAN-BUILT HYDRAULIC DREDGE.

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in Canada have just been installed in the machine shop, and the shipyard has been equipped with a new modern overhead traveling gantry built upon the same principle as that at Harland and Wolff's, Belfast. This gantry will handle all the material required in the largest ship that can ever be constructed in the yard, being 75 feet span, 60 feet high, and having a capacity of 10 tons. A pair of 50-ton shear legs, operated by electricity, is erected on the water front, for lifting heavy machinery on or off ships under construction or repairs. The premises throughout are equipped with steam, pneumatic, and hydraulic power, and, in view of a continuation of good business prospects, further additions to the plant and premises are contemplated in the immediate future. J. W. M.

street immediately in the rear of the Engineers' Club's property.

Mr. J. C. Kafer, president of the Engineers' Club, and Mr. John Fritz, the venerable ex-president of the American Society of Mechanical Engineers, then saw Mr. Carnegie and received from him a ready promise of a million dollars or more for the erection of one central building for the use of all the societies. It is understood that the societies shall raise the money for the purchase of the land.

Thus it appears that the long-projected plan is to be consummated, and it is to be hoped that the building will be as great a success in meeting the demands of the constituent societies as has been American engineering work in other fields.

DECK VIEW ON HYDRAULIC DREDGE.

Mr. Carnegie's Offer for an Engineering Building.

The subject of housing the several large engineering societies of New York city under one roof has often been under discussion, as the many advantages of such a move were generally realized. About a month ago Mr. Andrew Carnegie offered $1,000,000 toward the erection of such a building, and steps are now being taken by a committee of the societies to formulate a general plan and secure a vote on this question from their respective societies. The committee consists of fifteen, made up of three from each, namely: American Society of Civil Engineers, Society of Mechanical Engineers, the American Institute of Mining Engineers, the American Institute of Electrical Engineers, and the Engineers' Club.

The Engineers' Club recently purchased two lots on the south side of Fortieth street, between Fifth and Sixth avenues, and options have just been secured on five contiguous lots on the north side of Thirty-ninth

Reorganization of Cramp Company.—A loan of $7,500,000 has been advanced to the William Cramp and Sons' Ship and Engine Building Company by the depositing of stock of the company with the bankers representing the Morgan interests. The reorganization means that the shipyard is completely under the control of the new capitalists. Edward J. Stotesburg, Richard A. Rushton, George F. Baker will have charge of the finances of the company, as they were elected at the directors' meeting as voting trustees of the corporation. The old directors presented their resignations, but no action was taken. More than 50 per cent. of the Cramp stock has been deposited with Drexel and Company, thus consenting to the plan of reorganization. Stockholders of the company will vote on June 25 on the matter of increasing the capital from $5,000,000 to $6,000,000 and the bonded debt from $1,800,000 to $7,500,000.

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MARINE ENGINE DESIGN—COMPARATIVE PRACTICE, 1903.

BY JOHN CALDER.

In reviewing the field of marine engineering at the present date the most comprehensive grasp of the situation is obtained by arranging an analysis according to a quantitative function of the engine performances, which has invariably increased with the successive problems solved during the last fifty years, viz.: piston speed.

The demand for greater power has been met in several ways:

1. Increasing cylinder diameter.
2. Increasing cylinder stroke.
3. Increasing steam pressure.
4. Increasing revolutions.

1. Was the only means at disposal during the period of the horizontal athwartships marine engine and the unit of power was not reduced in cost.

2. Became practicable when the inverted engine was introduced and effected some reduction in weight, in cost, and in engine stresses.

3. Was long delayed owing to the slow progress of the boiler-making art during the first half of the above period and the lack of reliable materials for the higher stresses.

4. Commended itself from the first to the most observant marine engineers as the most economical of all methods of increasing power, and over the whole period there has been a steady rise of piston speed and speed of revolution as a result of growing experience in designing free ports and steam passages and the balancing and efficient lubrication of reciprocating and rotating parts of the engine.

At the same time there has been a steady reduction in the weight of the machinery and boilers per unit of power, and likewise in the cost. As the various steam-propelled craft became more and more specialized, the marine engineer was confronted with the task of securing highest speeds in each class on vessels of narrowly restricted dimensions and displacement, and was called upon to pack away the propelling apparatus in smaller and smaller compass per unit of power.

This problem, when faced in the most economical way, brought piston speed to the front as the determining factor, and its successive increases are landmarks in marine engineering progress. The cut on page 315 shows the growth in this respect during fifty years of a steam navy in which machinery space is always a compromise between the conflicting demands of armor and guns, and of a steamship company which demands a reasonable surplus-paying displacement in its fast vessels. It will be noted that both have progressed together throughout the whole period, and they are typical of the demand for higher piston speeds in all maritime countries.

First-class battleships and cruisers and the fastest merchant steamers to-day run at the same piston speed, 950 feet per minute, and the more remunerative intermediate service has alone restricted the number of the fast liners.

Leaving out of consideration some very small or very special craft, such as launches, small coasters, tenders, and tugs, there are seven main classes of service for which the marine engineer has to design appropriate propelling machinery, and within each of which he has to attain increase of power with reduction of unit weight in the case of the faster vessels in the group. These services are:

1. Side-wheelers.
2. Freighters.
3. Freight and passengers.
4. Passengers and mails.
5. Channel and sound express boats.
6. Battleships and cruisers.
7. Torpedo-boat destroyers and scouts.

The machinery particulars of such craft have been graded in the tables according to piston speed, and a glance at the data will show how systematically the designer has resorted to a higher rate of working when called upon to supply greater power with reduced unit weight.

1. *Side-Wheel Steamers.*—The heaviest machinery weight and space demand per unit of power is made by river and sound craft using the slow-revolution, simple or compound beam engine with cylindrical boilers and large, non-feathering wheels. The outfit is consequently expensive and entails also a greater displacement and size of vessel; on the other hand a very simple, easy-running machine is obtained.

Where first cost is a determining factor, or where speed results have to be obtained on a vessel whose length and draft are restricted by shoal water or limited manœuvering area on the surface, a substantial reduction in the weight per unit of power is imperative and the heavy beam engine has to be dropped. With the necessary advance in piston speed the two-cylinder compound inclined engine of specially strong materials and with small diameter, broad feathering wheels is introduced, using 100 to 120 pounds of steam, with light surface condensers of small capacity, moderate vacuum, and a uniform cylinder ratio of 1:3.5. In the higher-powered engines of this class forced draft is invariably used, and 11 I. H. P. per ton of weight has been attained by substituting the locomotive type of boiler. Where over 4,000 I. H. P. is demanded the size of the cylinders is inconvenient and a three-cylinder compound or triple type is used.

On long runs three-cylinder, triple-expansion, inclined engines are always used to reduce coal consumption and bunker space, and with 160 pounds steam give 10 I. H. P. per ton. A speed of 22 knots has been attained with 8,000 I. H. P. on a vessel 340 feet long, 38 feet beam, 8 feet 11 1-2 inches draft, and of about 1,515 tons displacement. In the numerous seagoing channel steamers of this type the paddle wheels receive severe usage and their reinforcement for stormy routes reduces the I. H. P. per ton to 9. The seagoing high-speed craft of this type are being gradually replaced by class 5.

2. *Freighters.*—This class of vessel has increased considerably in dimensions during the past decade and embraces all types of cargo carriers, from the modest 300-foot tramp, carrying 4,000 tons deadweight, which can trade in all waters, propelled by the regulation three-cylinder, triple-expansion engine, ratios 1:2.65:7.1, under 175 pounds steam, to much larger and more fully equipped twin-screw freighters on regular service be-

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MARINE ENGINE DESIGN—COMPARATIVE PRACTICE, 1903.

PISTON SPEED.	CLASS OF STEAMER.	SPEED OF STEAMER IN KNOTS.	MACHINERY PARTICULARS.								TYPICAL MODERN VESSELS.	I. H. P. PER TON OF PROPELLING MACHINERY VIZ.: ENGINES, BOILERS, AND WATER.
FT. PER MIN.	(1) PADDLE.		PROPELLER.	TYPE OF ENGINE.	CYLINDER ARRANGEMENT.	CYLINDER RATIO	BOILERS.	PRESS. LBS.	DRAFT			
400	River Paddle Steamer	13 to 15	Side wheels.	Inclined	2 comp. side by side	1 to 3.5	Cyl.	100	Nat.	.....		6.50
500	" " "	15 to 18	" "	"	" "	" "	"	110	Forced	Duchess of Hamilton.		7.22
600	" " "	18 to 22	" "	"	" "	" "	Loco.	120	"	Koh-I-Noor (Thames service).		11.00
700	" " "	18 to 22	" "	"	3 triple side by side	1:2.16:4.85	Cyl.	160	"	Lord Warden (Calais-Dover).		10.00
700	Sea Paddle Steamer... (Heavier paddle wheels required).	18 to 22	" "	"	" "	" " "	"	160	"	Leopold II. (Ostend-Dover route).		9.00
530	(2) Ordinary Freight, 300 to 450 ft.	9 to 11	Single screw.	Inverted.	3 triple.	1:2.65:7.1	Cyl.	175	Nat	Indrani and Californian.		4.85
530	" " "	11 to 13	" "	"	" "	"	"	200	Forced	Burma.		6.00
600	" " "	11 to 13	Twin screw.	"	" "	"	"	200	"	Nevadan and Mississippi.		5.85
600	" " "	11 to 13	" "	"	4 quad.	1:2.1:4 5:9.14		214	"	Texan.		5.48
700	(3) Intermediate Steamships, 450 to 600 ft.	13 to 16	Twin screw.	Inverted	3 triple	1:2.65:7.1	Cyl.	200	Forced	Rimutaka.		5.12
750	Very large Intermediate Cargo and Passenger, 600 ft. and over.	14 to 16	" "	"	4 quad.	1 2 07:4.24:8.82	"	214	As-sisted.	Celtic and Minnehaha.		4.37
800	(4) Passengers and Mail.	16 to 19	Single screw.	Inverted.	3 or 4 triple.	1:2.65:6 38	Cyl.	160	Nat.	Lahn.		7.00
800	" " "	16 to 19	Twin screw.	"	" "	"	"	"	Forced	Teutonic.		6.00
950	" " "	19 to 22	" "	"	4 triple.	1:2.07:6.87	"	175	Nat.	Lucania.		6.16
950	" " "	19 to 22	" "	"	3 quad.	1:2.08:4.16:8.71	"	220	"	St. Paul		5.95
950	" " "	19 to 23	" "	"	" "	"	"	"	Forced	Deutschland.		6.25
880 to 910	(5) FAST CHANNEL AND SOUND STEAMERS.	17 to 22	Twin screw.	Inverted.	4 triple.	1:2.28:5.84	Cyl.	160	Forced	Sandy Hook and Arundel.		8.00 to 9.70
950	(6) BATTLESHIPS AND CRUISERS, 1ST CLASS.	20	Twin screw.	Inverted.	4 triple.	1:2.66:7.00	Cyl.	175	Nat.	.....		8.50
950	" " "	23	" "	"	" "	"	"	"	Forced	H. M. S. Minerva.		11.02
950	" " "	23	" "	"	" "	"	Water-tube.	250	Nat.	H M. S. King Alfred, Louisiana, and Express.		12.00
1,200	(7) TORPEDO BOAT DESTROYERS & SCOUTS.	30	Twin screw.	Inverted.	4 triple.	1:2.36:5.50	Yarrow Water-tube.	250	Forced	Decatur.		41.00
Mean peripheral velocity of high-pressure vanes.	TURBINE-DRIVEN VESSELS.					NUMBER OF EXPANSIONS						
5,700	Turbine River Steamer and Turbine Steam Yachts.....	15 to 20	Multiple screw, 3 shafts, 5 screws.	3-cylinder, 1 H.P., 2 L. P., Hor. Comp. Parsons Turbine.		125	Cyl.	150	Forced	Queen Alexandra, Emerald, and Lorena.		12.00
6,000 (Estimated)	Turbine-driven Atlantic Liner, Pass. and Mail, or Battleship or Cruiser.....	23	Multiple screw, 4 shafts, 8 screws.	2 sets of 2-Cylinder Hor. Comp. Parsons Turbine.		135	W. T.	160	"	Superheated Steam.		16.00
6,200	Turbine-driven Pass. and Mail Channel and Sound Steamer.	25	Multiple screw, 3 shafts, 5 screws.	3-Cylinder Hor. Comp. Parsons Turbine.		125	"	170	"	Calais-Dover Packets (Building).		20.00
7,000	Turbine-driven Torpedo-Boat Destroyer and Scout, also very fast Yachts.....	25-32	Multiple screw, 3 shafts, 9 screws.	3-Cylinder Hor. Comp. Parsons Turbine		"	"	"	"	H. M. S. Velox and Tarantula.		55.00
10,000	Turbine Destroyers of maximum speed....	36	Multiple screw, 4 shafts, 8 screws.	2 sets of 2-Cylinder Hor. Comp. Parsons Turbine.		"	"	"	"	Viper.		70.00
8,000	Small 44-ton displacement experimental vessel, low coal radius and few auxiliary fittings.....	32	Multiple screw, 3 shafts. 9 screws.	3-Cylinder, 1 H.P., 1 I.P., 1 L.P., Hor. Triple Parsons Turbine.		150	"	150	"	Turbinia.		100.00

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tween deep-water harbors. The piston speed is 530 feet per minute, rising to 630 feet in the bigger engines.

As a rule the smaller tramps are still single-screw, and quite a number of the 8- to 10-knot vessels use natural draft. The larger 10- to 13-knot twin-screw types, however, have usually closed ashpit draft, and on long runs four-cylinder, quadruple-expansion engines are fitted to work at a piston speed which brings the machinery weight per unit of power well up to the corresponding single-screw figures, viz., 6.00 I. H. P. per ton.

The great majority of purely freight steamers launched in any one year throughout the world are engined with a more or less stereotyped single-screw triple engine of from 1,200 to 2,200 horse power, with auxiliaries and pipe arrangement similar to the detailed example given in the February issue of Marine Engineering. Owners of numbers of this type of vessel, which is the simplest case the engineer has to consider, are naturally conservative and progress is generally determined by the necessities presented to the designer by other and more difficult problems.

The economical production of moderate-sized freighters, with the minimum scantling and machinery equipment which will secure registration, has become the staple trade of many yards on the Lakes, the Clyde, and the east coast of England, where ship and engine building is highly specialized.

In the limited number of oil-carrying freighters oil fuel is now well established, but it is as yet barely introduced in the regular cargo service.

3. *Freight and Passenger Vessels.*—The most marked development in remunerative shipping enterprise has been seen during the last three years in this class of vessel, which has a much larger paying freight displacement than the first-class ocean liners, and, owing to the moderate speed sought, and to the fact that resistance to propulsion per ton of displacement steadily reduces with increase of bulk, its machinery space is relatively much smaller. The designer is therefore able to equip such craft with a fairly heavy type of four-cylinder, quadruple-expansion engine (ratios 1 : 2.07 : 4.24 : 8.82), which is now invariably twin screw and runs at a piston speed much lower than the faster craft.

In consequence the weight per unit of power is larger than any of the table, the result being durability of parts and freedom from accident. The *Celtic* and *Cedric* represent the largest vessels of this class, in which the fine vessels of the Atlantic Transport Line, the intermediate Cunarders, and the ships building at New London are smaller but excellent examples. On one of the Cunarders, the *Saxonia,* the British Admiralty tests of last year proved conclusively the remarkable efficiency of the Scotch boiler when moderately steamed as it is in such craft.

4. *Ocean Liners.*—These vessels, of enormous power, have practically reached their maximum performance as to the weight of the unit of power, viz., 6.25 I. H. P. per ton. At least this is so for reciprocating engines, and the new Cunarders will excel in bulk, but will probably not differ much in engineering features from the German vessels. Running at the piston speed of a battleship, their twin-screw, six- or eight-cylinder, quadruple-expansion engines and boilers represent the acme of marine engineering attainment, and leave but one-tenth, and, in the very largest craft, one-twentieth, of the vessel's capacity as paying displacement for valuable express freight. In the new and faster liners referred to there is every probability that this small margin will vanish altogether.

The result of the efforts being made at the present moment to attain reasonably low revolutions from marine steam turbines of high power will materially affect the future progress of the fast liner. Until then the financial risk is too great an undertaking, as it is well known to those who have had experience in turbine propulsion that the propeller, not the turbine, efficiency of high-speed craft is the weak point.

5. *Fast Channel and Sound Screw Steamers.*—This class of vessel, with inverted screw engines, has become the rival of the side-wheel steamers of the same speed and service, and on many railroad sea connection routes has already displaced the latter. The position of the former prime movers is in turn being assailed by the multiple-screw steam turbine.

The greater efficiency of the screw in comparison with the paddle wheel, and the possibility of using it in twin form on the shoal waters of terminals, for which the shallow-draft side-wheeler was formerly the only solution, have made it possible to supply the unit of power for the same weight. Additional advantages are gained at the same time in getting rid of heavy feathering paddle wheels liable to severe damage in rough weather, and in the safety secured by duplicate sets of inverted four-cylinder, triple-expansion engines in place of single sets of triple-inclined engines.

The manœuvering power of the screws is fully as good and the coal bill is also favorable. The vessels of this class are very fine examples of naval architecture and in machinery and fittings are practically miniature Atlantic liners. Their runs, however, being limited to from 20 to 60 miles, a considerable reduction is made in the auxiliary machinery equipment, and the lower cylinder ratios, 1 : 2.28 : 5.84, enable the unit of power to be obtained for 33 per cent. less weight than in the liners.

As length and draft are almost invariably fixed in this class of service by terminal conditions, every aid that tank experiments could give toward the best form of hull and propeller has been necessary, and the best result (1900) attained with reciprocating machinery during the last decade is that of the English channel steamer *Arundel,* 269 feet long by 34 feet beam by 8 feet 10 inches draft, on the New Haven-Dieppe route. This steamer, of about 1,020 tons displacement, attained 22 knots with 5,000 I. H. P., which is a reduction of 71 feet in length of vessel and of nearly 40 per cent. in I. H. P. for the same speed and practically equal deadweight capacity in the best attainable side-wheel results for such service.

6. *Battleships and First-Class Cruisers.*—In the engineering of these vessels coal economy and consideration of first cost of material are waived in favor of small bulk. The result is that on the same piston speed as the ocean liners a lighter and quicker revolution engine is built, and with cylinder ratios 1 : 2.66 : 7.00, natural-draft cylindrical boilers, and 175 pounds steam pressure, yields.

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in the older and nearly obsolete types, 8.5 I. H. P. per ton of machinery. This result is increased to 11.2 I. H. P. with forced draft not exceeding 1 inch water gage, and, with water-tube natural-draft boilers of 250 pounds pressure, reaches 12 I. H. P. per ton, or nearly double the best liner results.

Of course such power results cannot be maintained with anything approaching the certainty and duration of the corresponding mercantile craft, but, as a marine engineering problem, such warship engines present many interesting and difficult questions to the designer for solution.

7. *Torpedo-Boat Destroyers and Scouts.*—In these high-speed vessels of low coal radius almost all the free displacement is devoted to propelling machinery, and the unit of power for reciprocating engines is obtained with less weight than in any other problem presented to the engineer.

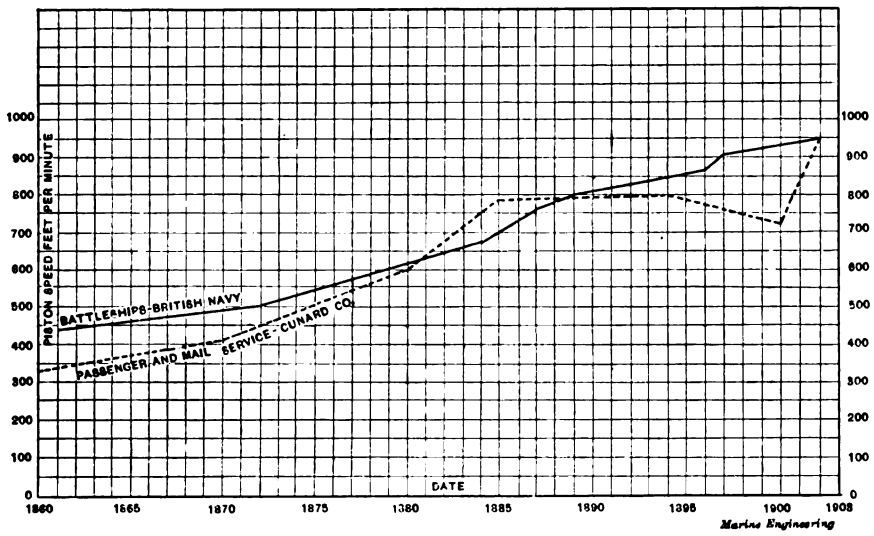
Coal economy is still less regarded than in the larger naval craft, though in both it is now subject to definite restriction, and the light water-tube boilers, usually Yarrow type, are forced to the fullest extent. In an even greater degree than the larger war craft all machinery weights are curtailed, and the working stresses of the strongest materials obtainable are carried to the maximum limit.

Under such conditions 41 I. H. P. per ton is obtained with great care in the operation of the machinery. The risks involved in running such craft are now being lessened somewhat by the reduction of the speed demand to a limit of 25 knots, which can be maintained for some hours, and the raising of both hull and engine scantlings will increase their seaworthiness and usefulness.

Turbine-Driven Vessels.—The seven classes of service just considered embrace the great bulk of the marine designer's work with reciprocating machinery, but the practicability of the marine steam turbine, and the adaptability of the screw propeller to the new conditions introduced by a great and sudden advance in the revolutions, have, within the last two years, considerably altered the engineering outlook.

Turbine screw propulsion has come to stay, and the question to be settled shortly is its range of economical application. It has been successfully substituted for reciprocating machinery in the smaller fast passenger steamers, with saving of weight and fuel, in steam yachts, and in the smaller war craft with speeds ranging from 15 to 36 knots. It will be seen from the table that its unit of power is obtained for decreased weight proportional to the mean peripheral velocity of the high-pressure turbine vanes which are analogous to piston speeds. This increase is obtainable by using larger turbines, or by increasing the revolutions, or both; but if the machine is made larger the unit of power will remain stationary as to weight and may even increase.

The table shows that the new prime mover is fully as flexible for varying conditions as the older, and produces from 12 I. H. P. to 100 I. H. P. per ton of machinery. Consequently in all services where low machinery displacement is essential, such as Nos. 1, 5, and 7, the weight ratios of 12, 20, 55, and 70 compare favorably with the 9, 97, and 41 of reciprocating practice. We may soon expect to see the turbine installed on the larger fast craft of both services.



CURVE OF PISTON SPEEDS DURING THE LAST FORTY-THREE YEARS.

Six-Masted Schooner Addie M. Lawrence.

The new type of six-masted schooners can no longer be termed an experiment, but a practical and successful vessel. The latest acquisition to the fleet is the *Addie M. Lawrence,* recently built and launched on December 17, 1902, from the same ways which the *Eleanor A. Percy,* the largest wooden sailing vessel in the world, had occupied at the yard of Percy and Small, Bath, Me. Although she is practically a duplicate of the *Percy* in construction, her dimensions are much smaller, and as measured by the custom house officials are, 292.4 feet on keel, 48.3 feet beam, and 22.3 feet depth of hold, while the gross tonnage is 2,807 and the net 2,195.

The greatest care was exercised in the selection of the material for her construction, and none but the best woods have been used. There is a two-tier keelson of birch and maple, measuring 13 by 15 inches; the main keelson is six-tiered, 14 by 14 inches, while the three

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tiers of sister keelsons on each side are of the same dimensions.

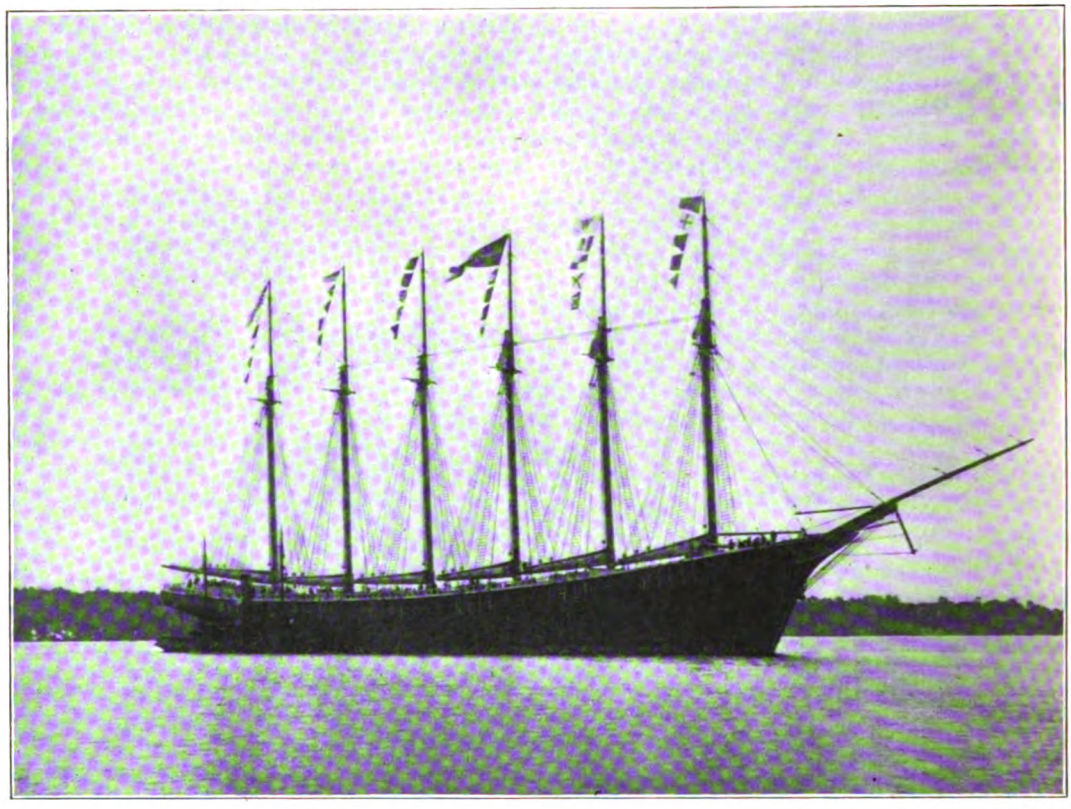
The stern post is of white oak, sided to 21 inches, and the inner post, stem, and apron are of the same material. There are 94 frames, and 10 cants aft, all of hard wood with hackmatack tops. The ceiling from the hanging knee strake to the keelson is 17 strakes wide, of yellow pine measuring 12 by 14 inches, between the decks it is 14 by 14, and the poop-deck ceiling is 8 inches through.

There are two and one-half decks, of yellow pine. The lower-deck beams are 13 by 13 inches. The two lock strakes to the lower hold are 13 by 13 inches, locked down over beam. There are three hanging knee strakes 14 by 14 inches, then two ceiling strakes 9 by 14 inches and two clamp strakes of the same dimensions. The main-deck beams are 9 by 13 inches, while the main rail is 6 by 15 inches, and there are three lock strakes, 10 by 13 inches, locked over the beam. The poop, which runs forward almost to the foremast, has beams 8 by 13 inches, with one main rail, two lock strakes, 8 by 12 inches, locked over beam. The planking is yellow pine, the garboard being 8 by 14 inches, while the main runs from 14 inches on the bottom to 6 inches on the gunwale. All the fastenings are of locust treenails and galvanized composition bolts with iron butts. On account of her great length and size, she is securely strapped on each side with steel bands measuring three-quarters of an inch in thickness and 12 inches wide. There are five discharging hatches on the main deck, each being 12 by 16 feet in the clear.

In the selection of materials for the masts, the utmost care was taken in securing the most perfect specimens of Oregon pine for the lowers, all of which are 118 feet in height and 30 inches in diameter at the base, with the exception of the foremast, which is 33 inches. The foretopmast is Oregon pine, 55 feet long and 20 inches in diameter, while the rest are of spruce, the same length, but only 16 inches in diameter. The gaffs and booms are also of spruce. All the rigging is of wire set up with turnbuckles, an idea which originated with the builders of the *Lawrence*, and she carries nearly 8,700 yards of the best quality duck sails.

There are three deck houses. The aft cabin, measuring 29 by 35 feet, comprises the captain's suite of rooms, the mate's private room, a bath room, dining and reception rooms, guest's room, closets, etc. It is finished in quartered oak, mahogany, and cypress. The pilasters and panels are mahogany, doors and stiles quartered oak, and the ceiling of both compartments of cypress, while the floors are of natural hard-wood finish. The aft compartment is decorated in black and gold and the forward in black and aluminum, the combinations formed being very beautiful. All the furniture is upholstered in leather, and the plumbing is of the open-work type. The midship house is 20 by 27 feet, finished in South Carolina pine, and comprises the galley, steward's and second mate's rooms, mess room, a large carpenter shop, and sail room. In the forward house, which is 22 by 29 feet, is the engine room, engineer's room, and the forecastle.

A complete steam equipment for handling the ship



SIX-MASTED SCHOONER ADDIE M. LAWRENCE.

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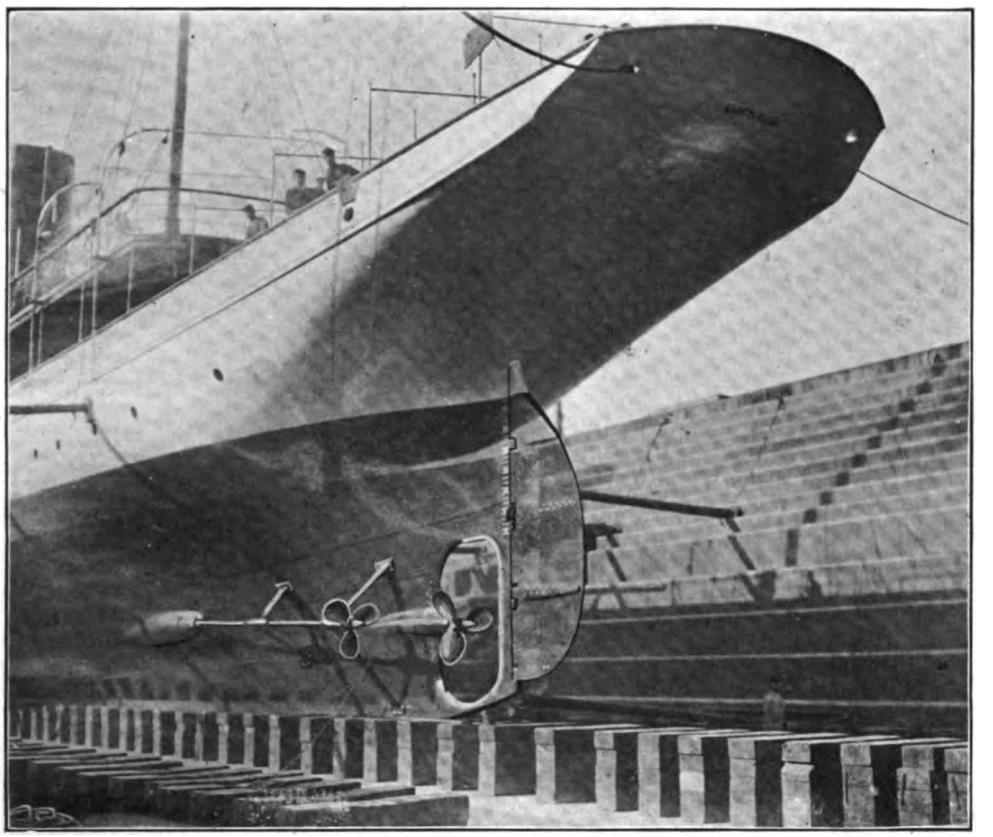
and cargo is installed. All the machinery aboard was furnished by the Hyde Windlass Company, of Bath, Me. It includes a No. 12 double-geared messenger attached windlass for handling a 2 1-2-inch standard chain, fitted with Hyde patent riding stoppers, and a winch head on the forecastle deck having direct connection to the windlass. This is connected by messenger chain to a 6 1-2 by 10-inch hoister, and steam is furnished by a 56 by 90-inch boiler. The craft also has two duplex pumps for feeding the boiler, washing down decks, etc., the dimensions of one being 4 1-2 by 2 3-4 by 4 inches, and the other 5 1-4 by 4 3-4 by 5 inches. She also has two 7 1-2 by 8 1-2 by 6-inch Hyde duplex wrecking pumps, one being located forward and the other aft. In addition to these is a set of 6-inch Adair pumps, also a 6 by 8-inch horizontal hoister aft. She also has a No. 10 Robinson steerer with a mahogany steering wheel and a No. 4 Hyde power capstan. Small winches are placed at the cargo hatches. Steam is supplied by means of a large boiler in the engine room. There are two stockless anchors, each weighing 8,500 pounds and attached to 240 fathoms of 2 1-2-inch chain. A 27-foot lifeboat is fitted with a 5 horse-power gasoline engine. There is also a 17-foot dinghy.

The *Addie M. Lawrence*, owned by J. S. Winslow and Company, Portland, Me., is the fifteenth vessel built by Percy and Small, and represents a cost of nearly $130,000.

Turbine Yacht Emerald.

The first turbine-propelled English-built yacht has recently arrived in the waters of New York bay after a stormy passage from the Clyde. The vessel is chartered from the owner, Sir Christopher Furness, to Mr. George J. Gould, and is now under command of Captain Tod. In reporting on the trip the captain says that although very heavy gales and seas were encountered he kept his yacht on the course the entire time and that she is a good sea boat.

The *Emerald* is 236 feet long, 18 1-2 feet deep, 28 feet 3 inches beam, and is driven by three Parsons turbine engines, each mounted on a separate shaft. As designed, the outboard shafts each were fitted with two propellers; but as it was found that the forward propellers on the wing shafts were not sufficient, these were taken off before crossing the Atlantic. The yacht was built at the works of Alexander Stephen and Sons, Ltd., Scotland.



STERN VIEW OF THREE-SCREW, TURBINE-PROPELLED YACHT EMERALD.

Wreck of the Schooner Charles L. Davenport.

During a thick fog on March 30 on Chesapeake bay the four-masted schooner *Charles L. Davenport* ran ashore at 5 A.M. off Old Point Comfort Light, about one hundred yards from the masked batteries at Fortress Monroe. The schooner was built in 1890 by Washburn Brothers, of Thomaston, Me., and was of 1,032 gross tons. She was owned by C. H. Washburn and commanded by G. Samuel Watts. Up to the present time no attempt has been made to move her.

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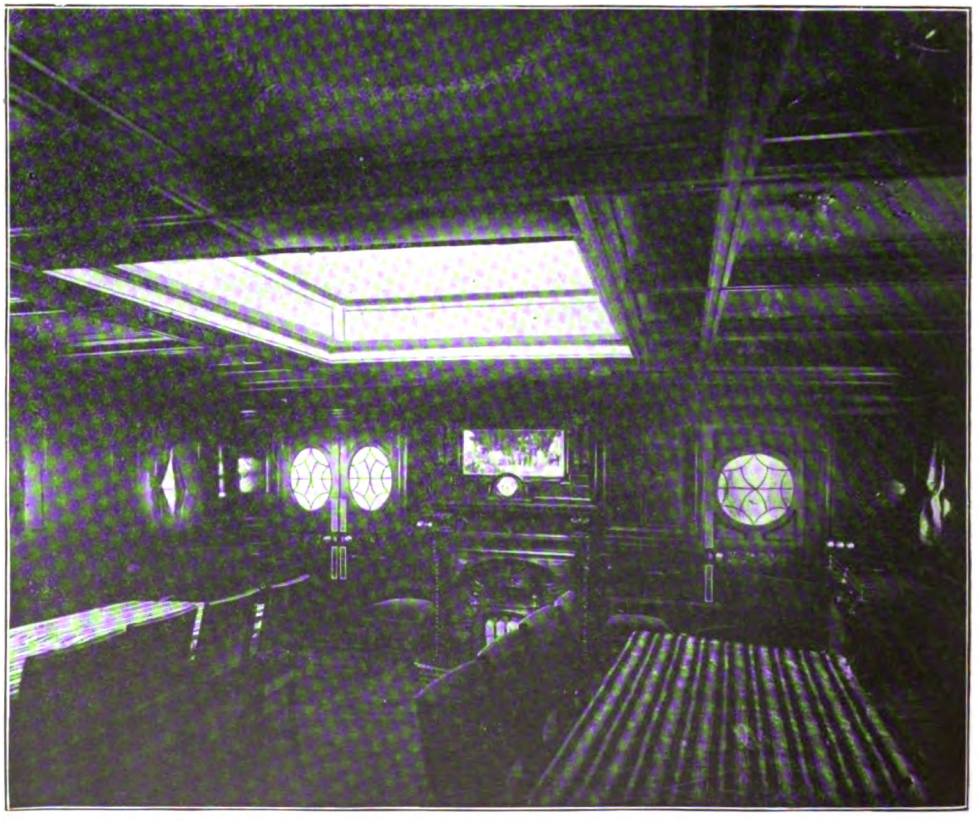
ENTRANCE HALL.



DECK SMOKING ROOM, TURBINE YACHT EMERALD.

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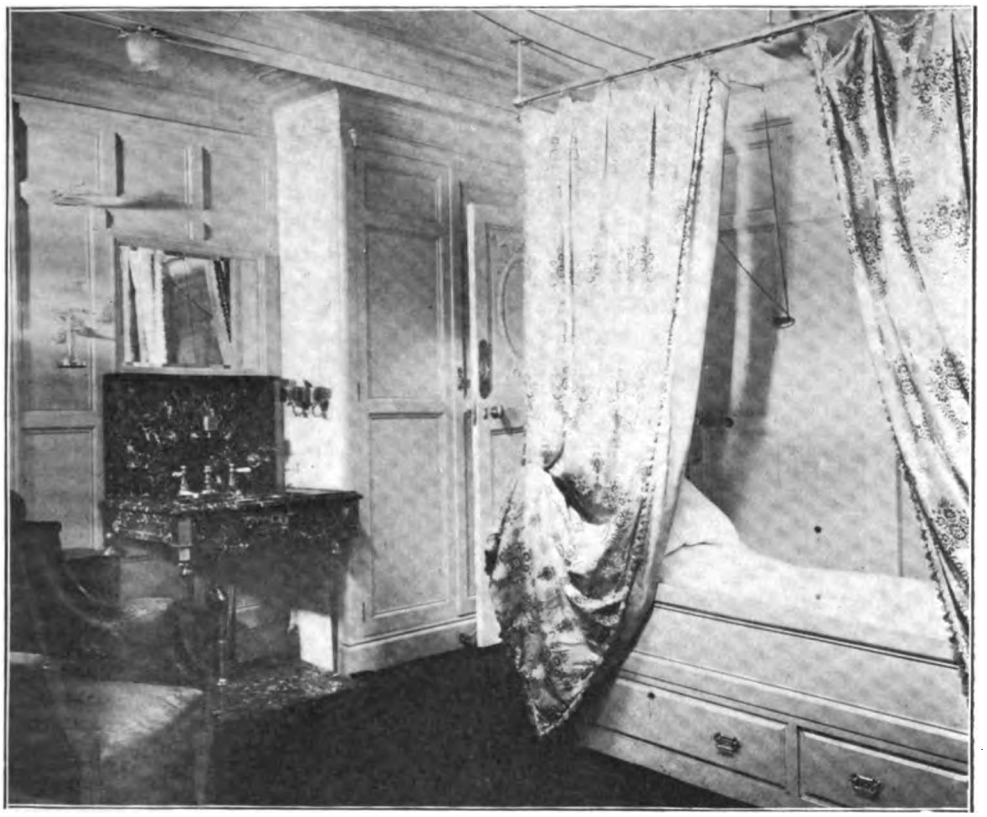
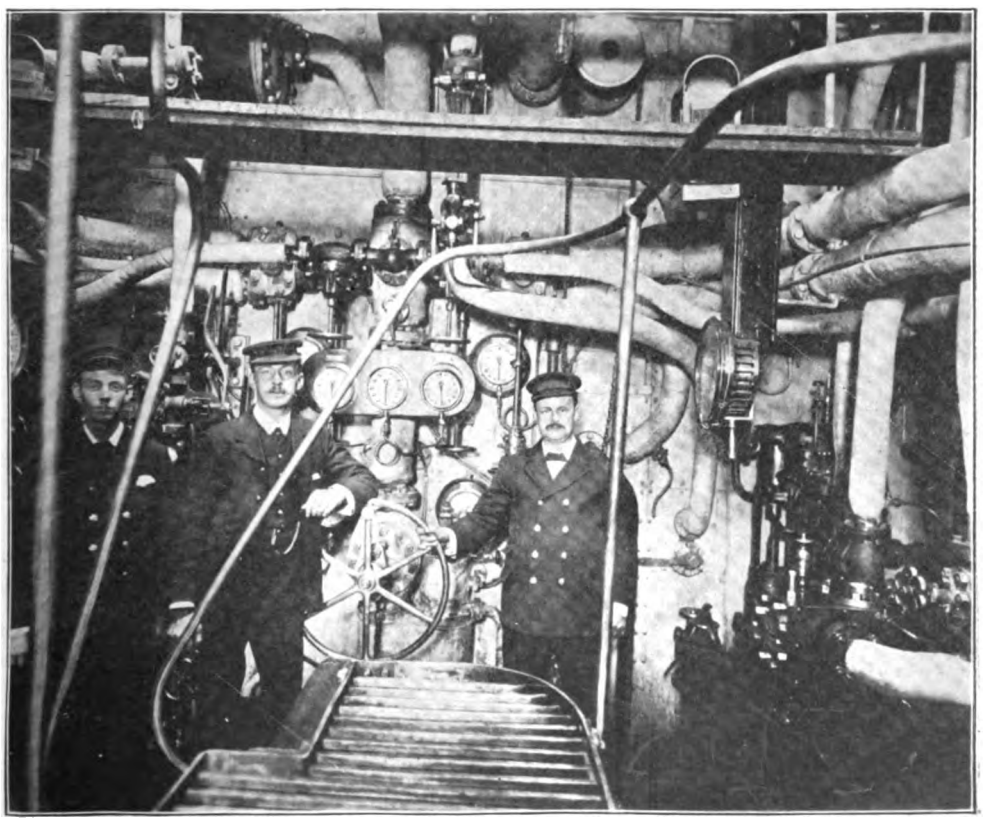


OWNER'S STATE ROOM.



ENGINE ROOM, LOOKING FORWARD, TURBINE YACHT EMERALD.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

THE American who reads in his daily paper, whether he be a capitalist or a union laborer, the almost innumerable accounts of strikes, lockouts, or boycotts now going on in almost every State in the Union, cannot but wonder what is to be the result of all this, and what is the cause of so much labor agitation at the present day. While it is neither the intention nor province of this paper to deal with labor questions, so seriously are they menacing the shipbuilder and shipping interests of this country that we ask our readers to pause for a moment and consider one or two fundamental principles. We must recognize that the inalienable right of every American citizen is to sell his labor where and as he chooses; that if he does not like his employer he has a perfect right to seek other employment; but never has he been given the right to prevent other men, whether or not in the union, working in his place. If the latter were true and the principle recognized in our law, then this country would be a despotism equal to any of the European sovereignties. It is true that the unions have been of advantage to the workingman, and we believe that labor should be organized as well as capital; but the two organizations should work together, for neither can succeed without the other, and the success of one brings success to the other.

Questions will always arise between employer and employee, but these should be subject to adjustment. When either side refuses to arbitrate it is fair to assume that that side is in the wrong. It is unusual for the labor organizations to refuse arbitration, yet this was the case up to the last moment with the striking engineers in the harbor of New York. No finer or harder working class of men will be found in any of the trades than marine engineers, and we feel the greatest regret that they were led into or advised to assume such a position. Fortunately for them, at the last moment they agreed to adjust their differences through arbitration, for, according to the rules of the United States Steamboat Inspection Service, by refusing to work or in any way preventing others from filling their positions the engineers are liable to lose their licenses; in fact, it is reported that several engineers at St. Louis lost their licenses recently for this very reason.

This is but one of the numerous phases of the present strikes. The country, outside of shipbuilding, is enjoying a wave of prosperity through the industry of our citizens, the great crops, and the demand for American products abroad as well as at home. The high prices of labor and material have not permitted shipyards to participate in this prosperity to so great an extent, and the numerous strikes of the boiler makers, blacksmiths, etc., along the coast, and especially in and about New York, have made the outlook in shipbuilding rather dubious. It will be well for labor agitators to consider the meaning of the reorganization of several of our shipbuilding companies before deciding to bring about more strikes. Here will be found evidences of the small percentage of profits, if not losses, in some of our large shipyards during the past three years.

Throughout the country manufacturers and employers of labor are now organizing to resist by concerted action the demands of the unions, stating that if this is not done it will be necessary to shut down. In contrast to the assertion that skilled labor is underpaid in this country will be found the statement of the members of the Mosley Industrial Commission which recently visited this country to investigate and report to their labor organizations in England the condition of the

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American laborer and methods of manufacture. The twenty-three members practically are unanimous in stating that the American laborer is better educated, better fed, better clothed, and better paid than his English cousin. Unless there is a check in the labor agitation our present prosperity will vanish as a myth and the unions will discover that they have killed the goose that lays the golden egg.

WE have, from time to time, called attention in these columns to the urgent necessity of shipbuilders devoting their attention to improving and inventing life-saving appliances that will lessen the danger to the lives of passengers and crew. In reviewing the few attempts which have been made along these lines, we find devices fitted on some of the big ships now turned out from the yards at home and abroad which may be considered quite distinct innovations, and which lessen the dangers of the sea. Keen interest was shown in marine circles in many countries in 1900, when the heirs of Anthony Pollock offered $20,000 to the person who should present a device which, to a competent jury, should be deemed to effectively reduce the liability of accidents to ships at sea. The jury was selected from among the officials of the Paris Exposition, which was held that year, and many hundred designs and models were presented in competition. None, however, were considered worthy of the prize. A second competition was requested, when certain restrictions were laid down as to the kinds of appliances. An award of $2,000 was made to one competitor, but again none of the contrivances were deemed suitable for the entire reward. One of the jury recently stated that he believed it best to refrain from offering a single prize of large value, but rather to establish a fund from which periodical distributions of prizes and medals should be made, and thus the interest in this subject kept alive from year to year.

In our opinion the greatest advance in the protection of lives at sea has been made along lines which the late Anthony Pollock little dreamed of—we refer to wireless telegraphy. Many of the Atlantic liners are now equipped with instruments for transmitting and receiving wireless messages, and with the completion of the stations at Poldou, England, and Newfoundland and Cape Cod on this side of the Atlantic, messages are transmitted to vessels throughout the voyage; thus at all times the ships are in communication with the land, and also, if necessary, with each other. One company has undertaken to publish a daily newspaper on board its ships at sea from wireless dispatches received each day. With this system adopted and in working order the long delays which sometimes befall the Atlantic liners may be prevented, or, at least, their causes known to those on shore, and, if necessary, assistance sent to them at once. We believe the seas are preeminently the province of wireless telegraphy, and if by its adoption a single ship may be kept from foundering or a single life saved, the expense entailed will be more than compensated for.

THE bill providing for the appointment of a commission to revise the United States Rules and Regulations relating to steam-boiler design installation and inspection, failed to become a law through the legislative deadlock which prevailed in Congress during the latter part of the session. It is now generally believed that legislative action is not needed for the appointment of such a commission by the Secretary of the Treasury. Thus, the committee of the American Boiler Manufacturers' Association have taken up the matter with the Secretary and urged the prompt appointment of the commission, in order that it may proceed with the programme previously outlined. Here again, however, there is possibility of some delay, due to the fact that the Steamboat Inspection Service, with various other bureaus of the Treasury Department, is, on July 1 next, to be transferred to the new Department of Commerce.

If the commission can be appointed without special action by Congress, it will be most unfortunate if such appointment should be delayed on account of the future transfer of the inspection service to another department of the government. The need for the revision is too great for postponements which are unnecessary. Too long already have our rules and regulations been utterly unworthy in every way the maritime interests involved, the status and achievements of American engineers, and the prestige of the United States in the engineering world. The programme outlined in the bill, and which was noted in our comments last month, seems in every way admirable, and if we may assume to voice the desires of both builders and users of marine boilers throughout the entire United States, we would call most earnestly for the carrying out of such a programme of study and revision with the least possible delay.

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Propellers for Launches.

Editor MARINE ENGINEERING:

I was much interested in the article on "Powering and Propulsion of Small Boats" in the March number, but it seems to me that the author uses too much pitch on all the wheels in the formula. I don't claim to be a propeller expert, but I have had some experience with both solid and reversible wheels, and I noticed that the engines that have the lower pitch wheels always seem to develop more power than the ones with higher pitch wheels of the same rated H. P., and, especially with reversing wheels, when I take the pitch off the boat makes better time and don't usually settle so bad aft. Of course some of the speed is due to the increased revolutions of the engine, thereby giving more power, but don't think it is all from the engine.

I think the pitch and diameter ought to be about equal, especially on the higher speed engines they are making now. (I mean in the ordinary pleasure and business launches. The racing machines are different.) There is an engine that is sold here a good deal that is supposed to make 600-650 R. P. M., and the 14 H. P. has a 20-inch wheel, 3 blades, 34-inch pitch. From the way I understand the theory of propellers, the more R. P. M. the less pitch they should have to get the best results. Take the electric launches made by the Electric Launch Company; their 5 H. P. motor has a 15 1-2 inch, 2-bladed wheel, 15-inch pitch, in a 30-foot boat, and they turn up 600 to 800 R. P. M., and the boats beat nearly all the gas-engine boats of the same size that have 6 and 8 H. P. engines.

Please give me your opinion on the above and oblige a subscriber. E. R. KOILE.

Editor MARINE ENGINEERING:

In reply to your correspondent I would say that the formula and methods referred to place no restriction whatever on the relation between pitch and diameter, and are quite as applicable for low pitch ratio as for high. In Table 3 the pitch ratio runs from 1 to 1.8 and this is intended to cover the usual range of this relation. The value to be used in any particular case must be determined by the special circumstances of the case. In the illustrative examples it was intended to keep the revolutions down to about four hundred, or somewhat less, in accordance with the practice of many of our best makers of marine motors. This led to the particular pitch ratios selected. If revolutions of five hundred and six hundred are available the pitch ratio will be correspondingly less. Your correspondent is, however, in error in assuming that there is anything inherently better about the low pitch ratio rather than the high. Extended experimental research has shown that where the propellers are properly designed the one may be equally as efficient as the other. The chief difference between the two, in point of result, is that the low pitch ratio, other things being equal, will efficiently absorb a given power on a smaller diameter than the high pitch ratio. This is clearly shown by the values given in Table 3 and may be the explanation of the fact noted by Mr. Koile, that low pitch ratio wheels seem to develop more power than high pitch ratio. If each one is properly designed, however, with reference to the conditions of its operation, the return in useful work or the efficiency will be substantially the same, independent of the pitch ratio employed.

Regarding the electric launches, the result stated might be explained in a variety of ways. It is quite possible that they may have developed for moderate distances very much more than the normal rate of power. The figures 5 H. P. for the electric launch and 6 or 8 H. P. for the gas-engine launch have no meaning without more accurate information as to the power actually developed. Or, again, it may be that the propeller for the electric launch is better adapted to its conditions than that on the gas-engine launch. This might arise from a limitation in draft resulting in a limitation of diameter. This would call for a low pitch ratio and high revolutions, a set of conditions more readily filled by the electric launch than by the other.

Thus, if a diameter of 15 or 16 inches is all that can be permitted, this will presumably call for low pitch ratio and high revolutions; and if the revolutions are too high for the motor, then the wheel thus operated must work at a disadvantage. If, for example, 800 revolutions are required for the best efficiency, while the gas engine can only be driven at 600, then it is obvious that the electric motor can better meet the conditions than the gas engine. The credit, however, is not due to the low pitch ratio in itself, but to the fact that it may in special cases be better able to meet the conditions imposed. On the other hand, conditions often arise in which wheels of high pitch ratio must be employed. Such conditions are always found in small boats driven at high speeds, either by steam or gas engines. Thus, on all torpedo boats, fast launches, etc., pitch ratios of 1.5 and higher are commonly found.

The purpose in all propeller design should be to select such conditions or features as will seem to promise the best results, having in view the special circumstances of the case in hand. In the solution of such problems experience of course enters very largely, and the article referred to by Mr. Koile was written for the purpose of aiding in the application of such experience, and without any attempt to lay down hard-and-fast lines in reference to the adoption of any special feature. Low pitch ratios are best suited to fulfill some conditions, high pitch ratios others; and the selection between the two, or through the intervening middle ground, must necessarily depend upon the special conditions of the problem in hand. W. F. DURAND.

The Future Traffic of Western Rivers.

Editor MARINE ENGINEERING:

Your recent articles concerning Western rivers I have read with interest, as for many years I have been identified with shipping on the Ohio. It is a deplorable thing to see these splendid navigable waterways almost denuded of shipping, save for the coal transportation, which will probably remain and grow, but there is little hope for anything different. The railways are direct and their freight-car switches go right into the factories and warehouses. The boats are remote and the rivers roundabout.

As to the passenger business, people want to travel

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rapidly and from convenient stations, instead of leisurely from wharfboats located at the edge of muddy and steep landing places. There are certain trades, as between Cincinnati and Louisville and Pittsburgh, where excellent boats will, for many years, find profitable passenger and freight traffic. The steamers engaged in these services are kept up to date and they secure many excursionists. It really seems that if the sight-seeing, pleasure travel from these three great cities and the half dozen smaller cities along the Ohio was properly worked by means of improved steamers, it would start a new era in that particular line. Fast and luxurious steel-built day steamers, with good provision against fire danger, thoroughly advertised, and landing at convenient, clean-kept wharves, might draw a vast business during May, June, July, August, September, and October. The fire danger upon the present style of boats is a great handicap, although the actual losses are less than railways, but it is hard to convince people of that latter fact.

It may be that in the future some liberal investment of capital in a new type of steamer, embodying better ideas and more economical machinery, may work a revolution along the Ohio and Mississippi, but I doubt it.

"READER."

Lining Up Marine Shaft.

From *Power* for April we make the following extract of a correspondent's description of lining up new shafting on board ship:

A 1-16-inch hole is drilled through forward engine-room bulkhead, hole in stern post bridged, and a 1-16-inch hole drilled through bridge, both drilled holes to correspond with shaft center. A light is then placed forward of engine-room bulkhead hole and it can easily be seen through these two 1-16-inch holes. After-tank bulkhead hole is then bridged, a 1-16-inch hole drilled through bridge, and bridge adjusted so the light can be seen through these three 1-16-inch holes. Circles can now be described around these holes in the stern post and after-tank bulkhead with the 1-16-inch holes for centers, bridges removed, and boring bar set by circles. Of course any number of intermediates may be erected before bridges are taken out to get height of seatings, chucks, etc. This way all errors of a sagging line are avoided.

To line from tail-shaft coupling, shaft-alley bearings, of which there is often only one for each section of shafting, are not used. Each length of shafting is blocked on two blocks in such a way that the overhanging ends balance the portion between blocks, otherwise the shaft will sag, throwing couplings out. Faces of couplings are left a little apart for lining up, so a very keen taper wedge can be used between them. If now the after coupling of after line-shaft section is central with forward coupling of tail shaft and the taper wedge enters the same distance all around between their faces, tail shaft and after section of line shaft are surely in line; the next length forward may be proceeded with. When all the shafting is in, engine bed with crank shaft in place is set in the same way and forward crank shaft center will correspond with the 1-16-inch hole drilled in forward engine-room bulkhead. Before blocks are removed from under line shaft, shaft-alley bearings are put in place.

X.

Pich Process for Brazing Cast Iron.

A paper was presented at the monthly meeting of the American Society of Mechanical Engineers, April 7, on the features of the Pich process for brazing cast iron, by Mr. Wilfred Lewis.

The general scheme of the process is, first, the use of a coating over the surface to be joined. This coating is a metallic oxide (usually the oxide of copper), made into the constituency of varnish by some suitable liquid and applied on the surface with a brush. The effect of the metallic oxide is to act as a reducer of the carbon on the surface of the cast iron to be brazed, so that it passes somewhat toward a condition of carbon steel. Without this treatment, a sort of greasy condition of surface prevents adhesion. This reduction seems to penetrate for some distance (even three or four inches) into the actual texture of the cast iron, the graphite disappearing under the action of the heat applied by a gas and air torch. The ordinary brass filings usual in any brazing process are then laid upon the fracture, and melt into the joint at about 1,800 degrees Fahrenheit, making a union which is as strong, or stronger, than the original texture of the cast iron. As presented before the society, the pieces broken were an inch wide by one-half inch thick, and the brazing was effected in a small muffler made of firebrick. The brazed pieces when broken parted in another section from that where the first break appeared. The process took about twenty minutes for the small pieces used in illustration.

It was explained that the process could be applied to mend the break in broken teeth of gears, in pulley or wheel castings, and in massive work, even up to the size of the casting of a good-sized shears or punch. The cost of the material, exclusive of the labor necessary to apply the process, was about one-half cent per square inch. Its application was explained further for the making of one massive casting out of parts which it was convenient to cast separately, and also one of the newest developments, which was to fill blowholes in massive castings. The surface of the cavity was coated with metallic oxide, which is known as the "ferrofix," and, after being brought up to the brazing temperature, melted cast iron from the ladle was poured into the cavity. It united either with or without the use of the spelter, and when broken the metal was stronger where the blowhole had been, and the union so perfect that even with a strong glass no trace of the brass film could be detected in cases where brass spelter had been used.

Quantitative tests on duplicate samples seemed to indicate that after the reduction and brazing process the strength of the casting was greater by 5 or 10 per cent. in many cases than it was in its natural state.

No claim was made for increased strength at the joint where the tensile strength of the original material was higher than the strength of the fused brass; but in cast iron, where the brass used was stronger than the casting originally, this effect could be produced every time with a joint properly brazed. The applicability of the system to brackets or inconvenient projections on castings was also referred to. There seems to be no limit as to size of the castings to which it can be applied. The time required varies with size and the number of torches to be used—from five minutes to two hours.

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Comparative Performance of H. M. S. Good Hope and U. S. S. Columbia.

In the April number of MARINE ENGINEERING was given an account of the trip of the H. M. S. *Good Hope* from Portsmouth, England, to Zanzibar, Africa, and from the *Journal* of the American Society of Naval Engineers is taken the following comparison of this trip of the *Good Hope* and that of the U. S. S. *Columbia* during her speed trial across the Atlantic in 1895. This comparison is of special interest, as it shows the actual number of men necessary to operate the engines of a modern cruiser when steaming at higher than cruising speed, and also as to the relative efficiency of Belleville and Scotch boilers.

The *Good Hope* was subjected to a test severer than most warships have to undergo, and it will be recalled that she is of the armored-cruiser type, of 14,000 tons displacement. A careful examination of her performance will indicate what sustained speed may be expected of warships when in service.

"The comparative results would indicate that the performance of the U. S. S. *Columbia* has not been surpassed by H. M. S. *Good Hope,* although the latter vessel is one of the latest examples of naval construction—in fact, a warship lately commissioned, and one launched seven years after the American cruiser with which she is compared.

"The trip of the *Good Hope* was probably intended by the Admiralty to prove a record performance. It was certainly so regarded by the naval world. To carry the Hon. Joseph Chamberlain as a Special Commissioner, the *Good Hope* was presumably selected by reason of the fact that she is a representative of the speediest class of large ships of the British navy. It was rather a good omen that she bore the name she did.

"As it was expected that the ship would make a record-breaking journey, her performance was closely watched by naval architects, marine engineers, shipbuilders, and naval officers. It was also well understood that her installation of Belleville boilers was on trial. In view of the important mission upon which the ship was sent, it can also be presumed that a trained and experienced force was detailed for the stokehole, so that the boilers received the best possible care and attention. The number of men detailed for duty in the fire rooms showed that at least an adequate complement had been provided.

"There was also a good-sized quota of men in all the higher ratings, so that particular attention might be given to the operation of all the auxiliaries in both engine and fire rooms. This complement, however, was not nearly as large as that deemed necessary by the builders of the vessel when conducting the official tests demanded by the government's contract.

"The voyage of the *Good Hope* was via the Mediterranean, Suez Canal, and then down the African coast to Durban. As the problem given the ship's complement was to steam the vessel at a regular speed of 17 knots, the route through the canal, although somewhat longer than that around the cape, favored the ship, since it permitted several stops to be made, and probably insured for the ship easier weather. While stopping at Suez and Zanzibar there were opportunities to make minor repairs and to secure fresh water. In other ways the journey through the Suez Canal assisted in diminishing the labor and strain of the engineers' force.

"The start was made from Portsmouth, England, November 25, 1902, 27 of the 43 Belleville boilers being used to secure the required power necessary for making the prescribed speed. Heavy weather was only experienced in the Bay of Biscay, and then it was necessary to slow down for only a few hours. Afterward the regular routine was carried on, and this routine has been described in the text of the article. It will be noted that occasional trouble occurred in the engine room.

"Reverting to the voyage of the U. S. S. *Columbia* from Southampton to New York, that vessel steamed out of the English port with fires in all her furnaces, the boiler installation consisting of 8 double-end Scotch boilers, 4 furnaces being at each end. At no time were fires hauled in any furnace. The vessel ran at full speed during the entire voyage, except for four hours when the ship was slowed down on account of fog.

"The *Columbia* was ordered to proceed to New York, using all boilers under natural draft, and to use all three sets of engines. For the first two days the limit of coal consumption was not allowed to exceed 200 tons per day. During the remaining four days the limit was not allowed to exceed 225 tons per day. The average coal consumption during the trip was about 212 tons per day.

"It is exceedingly regrettable that the *Columbia* was not run under forced draft for a day or two after leaving Southampton. It would then have been possible, by reason of the arrangement of the ship's bunkers, to have supplied the furnaces with all the coal that could have been burned. When it was suggested, near the end of the run, to use forced draft, it was found that it would not be possible under such conditions, due to the fact that all the bunkers in proximity to the fire rooms had been emptied, and therefore sufficient coal could not be fed to the boilers when the consumption was greatly increased. The experience of the *Columbia* in this respect conclusively shows that the question of rapidly getting coal out of the bunkers is one of military importance, and that more attention should be given to the subject.

GENERAL FEATURES OF BOTH SHIPS.

	H. M. S. Good Hope.	U. S. S. Columbia.
Displacement, tons	14,100	7,350
Length	500	411.5
Breadth (load line)	71	58.3
Draft, mean	26.5	22.4

TRIAL FIGURES.

Knots speed	23.05	22.8
R. P. M.	122.4	121.72
I. H. P.	31,088	18,509.2
Pressure	....	145
Boilers	43 Belleville	8 Scotch
Boilers in use	27	all

"The following deductions can be made:

"1. *Columbia's* average speed per day exceeds that of *Good Hope's* maximum.

"2. *Columbia's* daily run exceeds *Good Hope's.*

"3. *Columbia's* maximum speed per hour exceeds *Good Hope's.*

"4. *Columbia's* average speed per hour is greater than *Good Hope's.*

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"5. *Columbia's* average horse power is greater than *Good Hope's.*

"6. *Columbia's* consumption of coal per horse power is less than *Good Hope's.*

"7. *Columbia's* coal consumption per 1,000 tons of displacement at 10 knots is less than that of *Good Hope.*

"In making comparison between the *Good Hope* and the *Columbia,* the respective displacement of the two ships should be considered. The facts should also be remembered, however, that the *Columbia* had a much smaller complement of men in her fire rooms than did the *Good Hope* in developing practically the same horse power. As all fires were lighted in the furnaces of the *Columbia,* the fire-room conditions of that vessel ought to have been much more severe.

"The following comparative statement as to the performance of H. M. S. *Good Hope* and U. S. S. *Columbia* will be of interest to all the readers of the *Journal* in noting in some respects the progress that has been made in naval engineering design during the past five years.

"The records of the two vessels are also shown in tabular form:

.....	H. M. S. Good Hope, Nov 25-Dec 26, 1902.				U. S. S. Columbia, July 26-Aug. 2, 1895.	
	Best day run.	Portsmouth to Port Said.	Suez to Zanzibar.	Zanzibar to Durban.	Best day's run.	Southampton to New York.
Total knots run	....	2,905	2,840	1,590	....	3,090
Day's run, knots	440	376	401	356 5	462	442
Speed, average knots per hour	18.8	15 7	16 7	14 85	19.25	18.41
Days, straightaway	....	7.72	7.1	4.46	....	6.98
I. H. P., main engines	10,639	10,175	8,571	6,600	10 554	9 576
" aux. machinery	....	....	....	....	....	140
Tons of coal per day, all purposes	282	221	254	178	230	212
Tons of coal per day for auxiliaries	....	....	....	....	....	11.33
Pounds of coal per I. H. P. per hour, main engines	2.3	2.31	2.59	2.34	1.93	1.95
Pounds of coal per I. H. P. per hour for all purposes	2.48	2.55	2.69	2.74	2.03	2.07
Distance run per ton of coal, knots	1.56	1.70	1.58	2	2	2.08
Pounds of coal consumed per knot run	1,435	1.316	1.419	1,119	1,115	1,074
Pounds of coal used per ton of displacement	2.38	2.24	2.42	1.90	3 6	3.5
Estimated relative coal consumption per 1,000 tons displacement at 10 knots	D. S.		9.49	.....		8.98

TABLE OF PERFORMANCES OF H. M. S. GOOD HOPE AND U. S. S. COLUMBIA.

"To accomplish the satisfactory results noted for the United States ship, it may prove interesting to compare the working personnel of the engineer's force:

H. M. S.	U. S. S.
1 fleet engineer,	1 chief engineer,
2 engineers,	1 passed assistant engineer,
4 assistant engineers,	2 assistant engineers,
2 artificer engineers,	2 naval cadets as engineers,
3 chief engine-room artificers,	12 machinists, chief and 1st class,
20 engine-room artificers,	3 boilermakers,
10 chief stokers,	1 blacksmith,
23 leading stokers, 1st class,	8 water tenders,
10 leading stokers, 2d class,	15 oilers,
211 stokers, 8 stokers, 2d class,	67 firemen, 1st and 2d class,
6 engine-room artificers for instruction,	78 coal passers,
83 seamen, used as coal passers, stokers, tube sweepers, etc.,	12 seamen detailed from deck,
375 total engine-room complement H. M. S.	202 total engine-room complement U. S. S.

"The above comparison ought to give some pretty conclusive evidence as to whether or not there is an overcrowding of men in the fire and engine rooms of the United States warships. It will be observed that the horse powers developed on the two ships were nearly the same, and yet 83 men from the deck were detailed for duty in the stokeholes of the *Good Hope,* while only 12 of the deck force were called upon for fire-room work during the run of the *Columbia.*"

PERSONALS.

Irving M. Scott, of the Union Iron Works, died of heart trouble in San Francisco, on Tuesday, April 28. This is a heavy blow to the shipbuilding interests of the country, as Mr. Scott stood in the first rank of that industry. While with the Union Iron Works Mr. Scott had under his supervision the building of the war vessels *Oregon, San Francisco, Monterey, Ohio, Olympia, Charleston, Wilmington,* and *Marietta.* Mr. Scott was born at Hebron Mills, Baltimore County, Md., in 1837, and began his business career as a draftsman.

J. W. Hendry, formerly hull draftsman with the Bath Iron Works, is now with the New York Shipbuilding Company as hull draftsman.

Charles R. Sessions, who was formerly ship draftsman at the Union Iron Works, San Francisco, Cal., has taken a position as ship draftsman with the New York Shipbuilding Company.

David Bell, the veteran shipbuilder of Buffalo, died on Monday, April 20, in his eighty-sixth year. Mr. Bell was of Scotch birth and had lived for over sixty years in Buffalo and was one of the pioneers in the iron business. At his works he also in the early days built locomotives which were the largest of their time. Most of his work was in iron shipbuilding and among the vessels turned out are many of the old revenue cutters. Mr. Bell was always a very public-spirited man and took the greatest interest in the young men.

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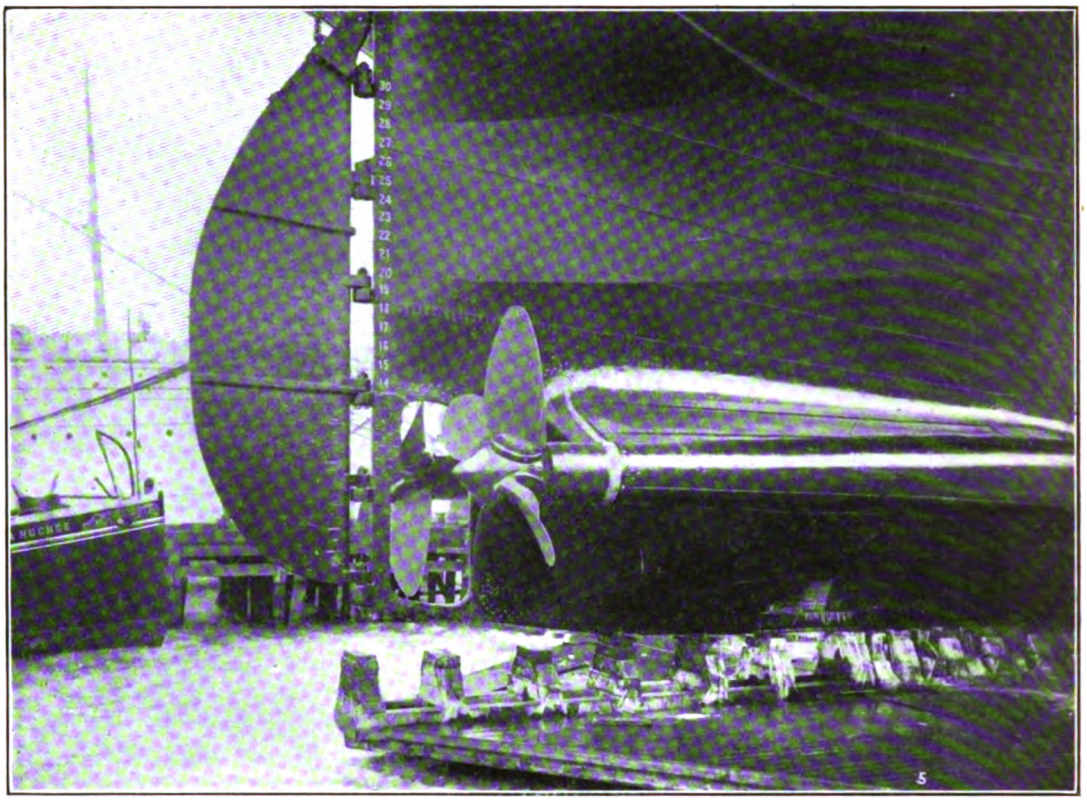

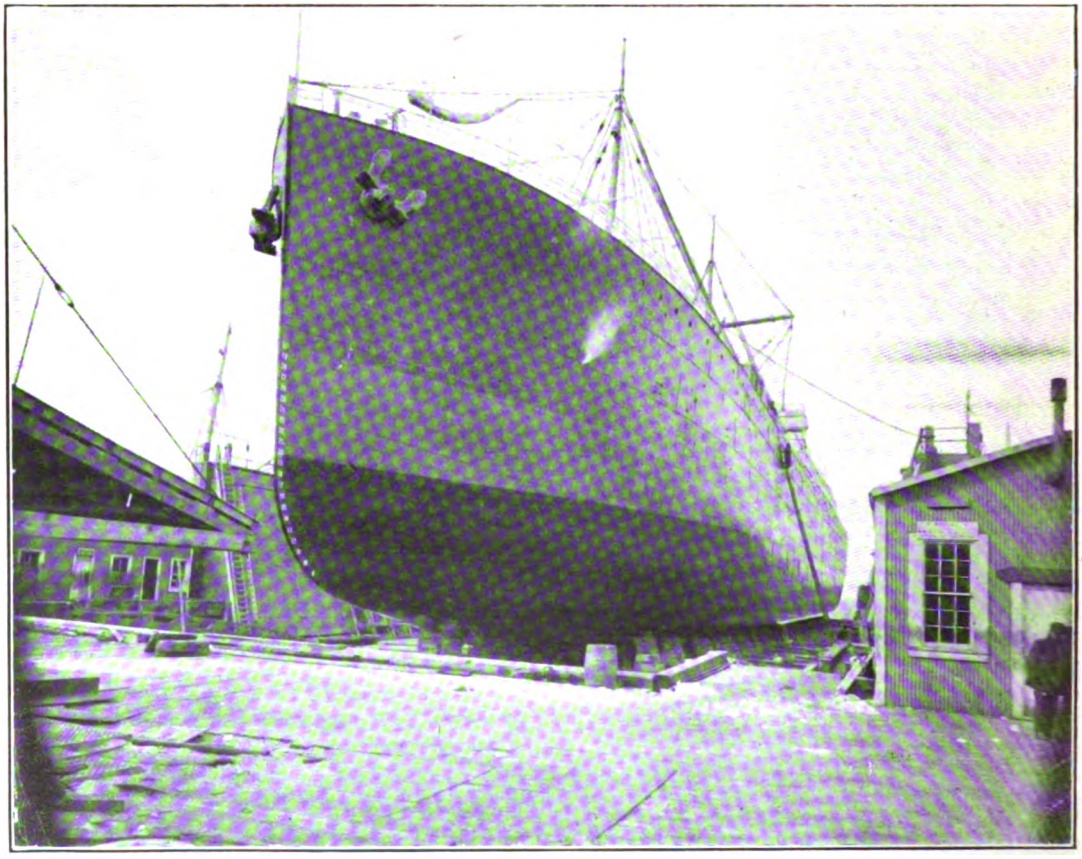

BOW AND STERN VIEWS OF THE NEW FREIGHT STEAMSHIP MASSACHUSETTS, IN DRY-DOCK AT MORSE IRON WORKS, BROOKLYN, N. Y. THIS SHIP WAS RECENTLY COMPLETED BY THE NEW YORK SHIPBUILDING COMPANY FOR THE ATLANTIC TRANSPORT LINE.

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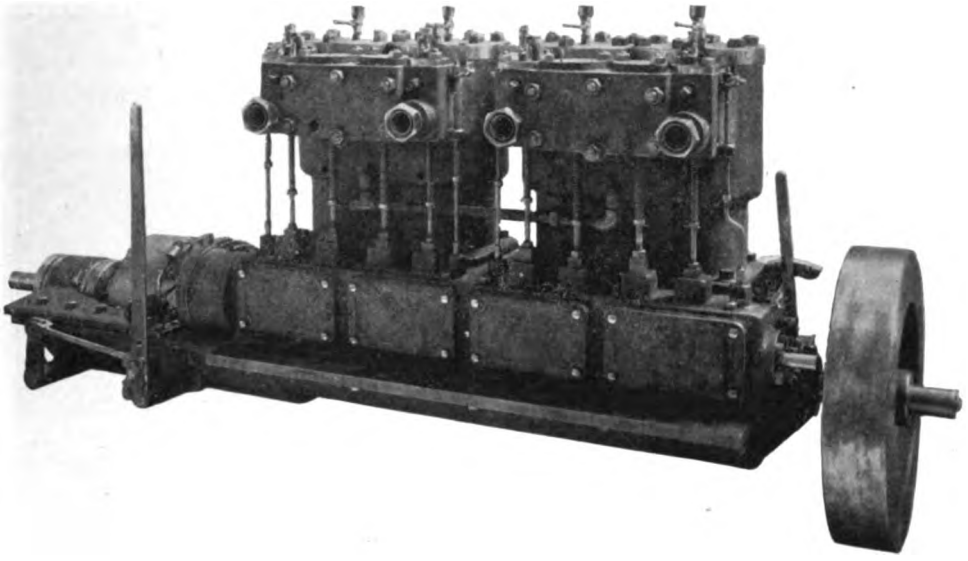
ENGINEERING SPECIALTIES.

Four-Cycle, Four-Cylinder Marine Engine.

The 25 horse-power four-cycle, four-cylinder marine engine herewith illustrated, made by the Frank M. Watkins Manufacturing Company, Cincinnati, Ohio, embodies the latest improved ideas in this type of motor on the market to-day. The material, workmanship, and construction are all of the very highest grade, all bearings are bushed with heavy phosphor bronze, while the cams, etc., are case-hardened, insuring long life of the engine. The crank shaft is made extra heavy and of the very best grade of open-hearth steel, while the connecting rod is made of heavy phosphor bronze. All parts of the engine needing attention are accessible.



MARINE GASOLINE ENGINE OF THE MULTIPLE-CYLINDER, FOUR-CYCLE TYPE.

The igniting apparatus is of the hammer-break type. One of the most important parts on a gas engine is the igniter plate, and here it is that most of the trouble is apt to occur on account of the plate being poorly constructed, poorly insulated, and inconvenient to clean. The igniter plate used on this engine is made to overcome these points; the insulated pin is covered with mica washers 2 1-2 inches long, thus making it impossible for the electric current to pass over the insulation. The igniter point can be easily cleaned in an instant by turning a small thumb nut while the engine is running.

The cylinder heads and valves are all well water-jacketed, and the water pump is made of brass, being what is known as the plunger type, and placed in such a position on the engine that it is easily accessible. The pump is fitted with a special attachment to prevent hammering and jarring of the pipes, which is very annoying and damaging to an engine.

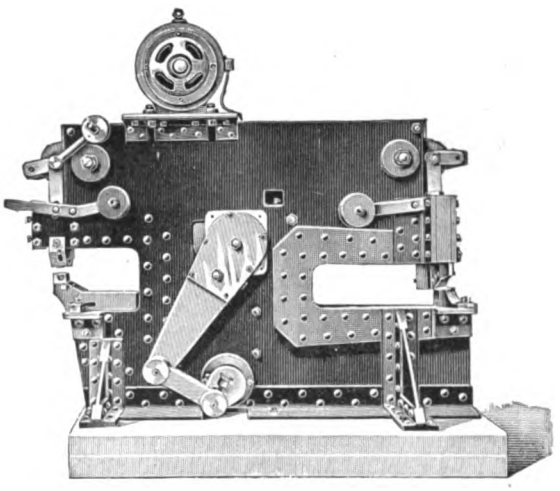
The inboard reverse gear used on these engines is of the enclosed type, with sprocket gears, which are considered better than bevel gears. All gears are of bronze and steel, running on hardened steel spindles. The engines are fitted with roller thrust bearings to catch the thrust for both forward and backing motion. The lubrication used is of the latest improved system.

Further particulars regarding this engine can be obtained by writing the manufacturers.

Patent Punching and Shearing Machine.

The Johns patent punching and shearing machines are made of wrought iron and steel, which means that they are lighter and much stronger than machines of cast iron; they are also fitted with most economical driving mechanism, thus gaining great saving in the driving power required. The machine may be driven by a small motor placed conveniently on top or at the side. The main shaft runs in a gun-metal bush with ring lubrication, and drives a crank through which power is transmitted to the punch and shears. A flywheel is mounted on the main shaft. By means of the connecting levers the greatest pressure is exerted at least expense of power.

The machines occupy small floor space and may be handled by unskilled workmen. Also, on account of the material of which they are made, they may be left outdoors without protection from the weather. The machine here illustrated is a combined shears and punch.



PUNCHING AND SHEARING MACHINE.

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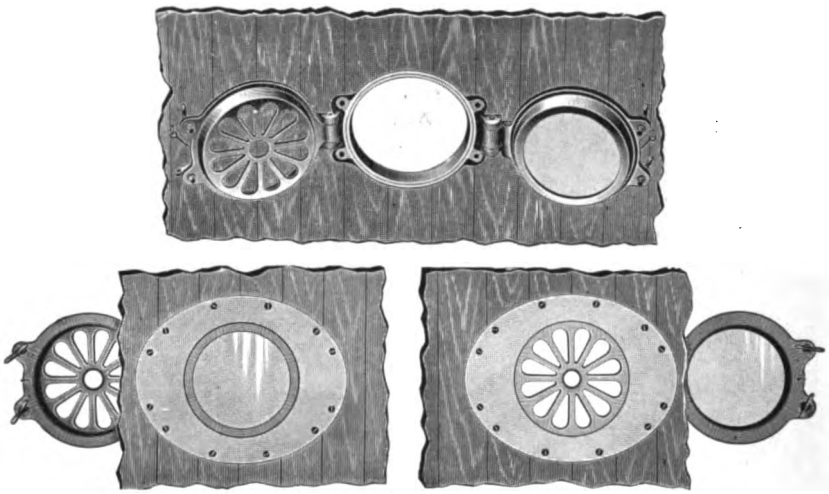
In large shops, where most of the punching and shearing work is done at the same time, a single plate shear and an extra bar cutter are to be preferred, so that plates to be cut do not interfere with the punching. The type here shown has an overhanging jaw for punching flanges of beams and channels as well as webs, plates, etc. The die block consists of forged steel and does not have to be changed for the different kinds of work. The jaws may be made of any depth. The shears are fitted with adjustable knives set at an angle of 60 degrees. Both tools have a quick-return motion, and the plunger makes a pause at the highest position, thus giving time to shift the material and to make use of every stroke.

These machines are built in a variety of styles to perform different classes of work, and further particulars may be obtained by writing to the makers, Henry Pels and Company, Morris Building, New York, N. Y.



COMBINED DECK LIGHT AND GRATING. VIEWS TAKEN FROM BELOW AND ABOVE.

Combination Deck Light and Grating.

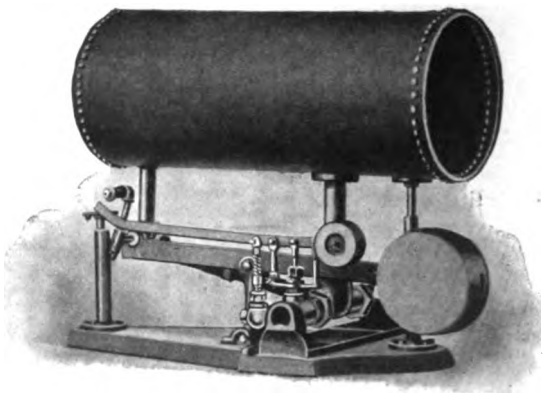
The accompanying views illustrate the form of combined deck light and grating which is made by the Edson Manufacturing Company, 255 Atlantic avenue, Boston, Mass.

The device is simple in construction and especially adapted for requirements on board yachts. It consists of an oval plate 14 by 11 inches, in which is set an 8-inch ring for receiving from below either a deck light or a grating. The frame holding the light is fitted with a ring carrying a rubber packing. This is hinged on the lower side of the plate and is held by a screw-hinged joint and two thumb screws used for clamping the frame upon the rubber packing to make a water-tight joint. These lights are made with clouded or clear glass, as desired, about 5-8 of an inch thick and amply strong to meet any required strain. The diameter of the exposed glass is 7 inches. When it is desired to replace the light with the grating the two thumb screws are loosened and the plate drops down, swinging back upon its hinge, and may be hooked back out of the way. The grating, which is also attached to this frame on the opposite end, works upon a hinge joint with screw, the same as the light. This grating is not provided with packing, as it is not necessary. It carries two thumb nuts or screws, the same as the light, so arranged in the frames that it is impossible for them to become detached or unscrewed from their place. Both the grating and light, when screwed into their proper position, are flush with the plate and with the deck.

This light is made of wrought brass, nicely finished, and should appeal to yachtsmen as a long-felt need for a combination deck light with grating all in one plate.

The Morehead Return Trap.

The condensation from any steam-heating apparatus must be removed, and the more quickly it is done the drier and more effective will be the heating surfaces. It is the greatest extravagance to waste this condensation, as it is pure water and hot. The most effective way to utilize the heat it contains is to deliver it directly into the boiler, and in no other manner can the condensation be handled as quickly and with the same economy as with a return trap.



PATENT RETURN TRAP.

The Morehead return trap is constructed of steel, the heads and longitudinal seams being closely riveted and calked to withstand any pressure carried on the boiler without breaking, which is impossible with cast-iron traps. It is the embodiment of simplicity, there being no rubber joints to blow out or leak, and only one valve,

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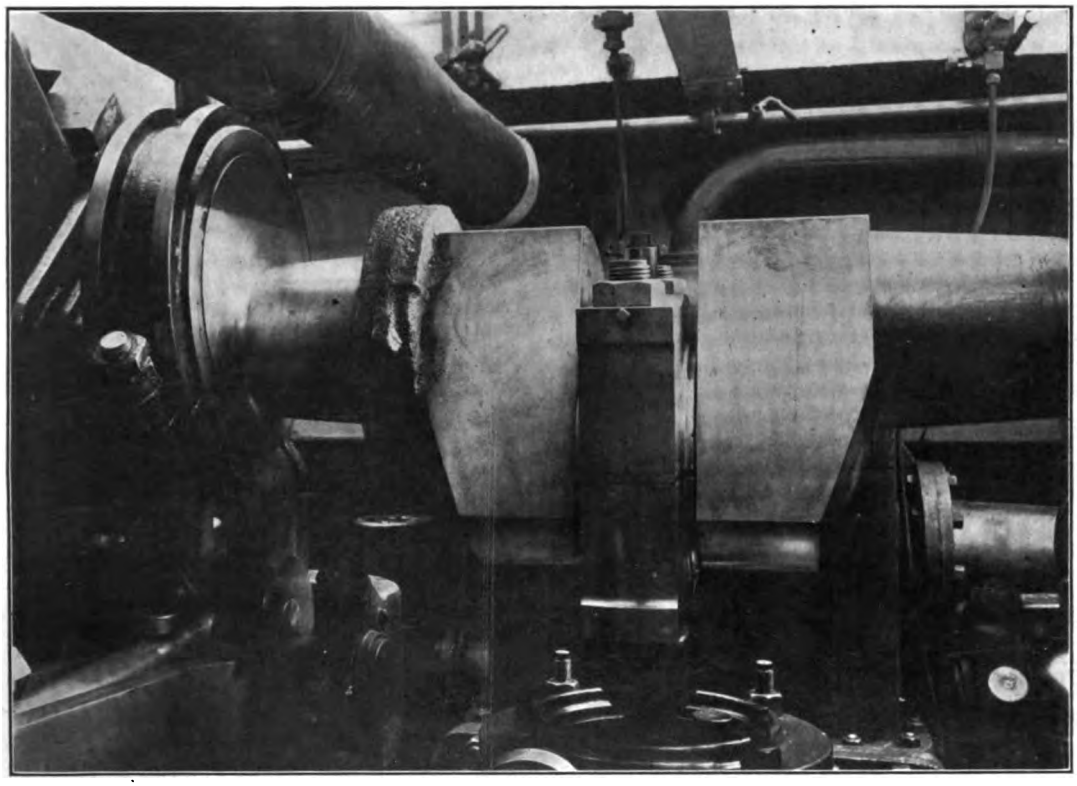
which is on the outside. All working parts are on the outside, in plain sight, and easily accessible. There is no ball or globe float inside the receiver to collapse, leak, rust, or stick.

This trap is located six feet or more above the water line of boiler. The water from the condensing surfaces is forced by the pressure of steam from behind through a pipe leading to the trap, with a swing check valve close to the latter. As soon as sufficient water has entered the receiver to overcome the counterbalance the receiver tilts down, allowing the water to pass through the discharge pipe, at the same time opening the steam valve, which has a pipe connected with the dome of the boiler.

By equalizing the pressure on the surface of the water in the receiver with that in the boiler, the water, in simple obedience to the laws of gravity, flows into the boiler. As soon as the receiver is empty it tilts back as before, and again refills. When once set up it requires no further attention. It takes the water from the condensing surfaces whether they are above or below the water level in the boiler, and automatically returns it to the boiler at the temperature due to the pressure at which the steam is condensed. There is no outlet by which the steam can be wasted. The trap is quick and positive in opening and closing and in delivering the water into the boiler against any pressure, regardless of fluctuations of pressure. It may also be used to supply all the water needed in the boiler from the feed-water pipe, providing there is enough pressure on the main to lift the water to the trap, thus performing the duties of a pump or injector. It operates equally well with high- or low-pressure coils, or coils using exhaust steam, allowing no condensation to collect in them.

Where a return trap is not employed the usual way of handling condensation is by means of a pump. A comparison of the two methods shows many points of advantage in favor of the former. A pump will not lift water at a temperature exceeding 212 degrees; a Morehead return trap will. A pump consumes an extravagant amount of steam to do a very little work, while a Morehead trap takes very little indeed. It is claimed that it requires practically no attention; needs no lubrication; will not race or run away; is noiseless; requires little room and no foundation. Full information may be obtained by addressing the American Blower Company, of Detroit, Mich., or any of its branch offices.



BROKEN SHAFT REPAIRED IN PLACE BY THE USE OF THERMIT IRON.

Making Repairs by Thermit Iron.

Two interesting repairs of a broken shaft and stern frame have taken place on the other side of the Atlantic by the use of Thermit iron. This material for welding was patented by the Allgemeine Thermit Gesellschaften, Essen-Ruhr, Germany, the American agent being Mr. C. B. Schultz, 149 Broadway, New York, N. Y.

This last January the Hamburg-American steamer *Sevilla*, of 900 tons, collided on the river Elba with another steamer and broke her stern post. The section at the place repaired is 19 5-8 inches by 7 7-8 inches. Heretofore the repairing of all such damage could only be effected by taking the stern post out and repairing it in the

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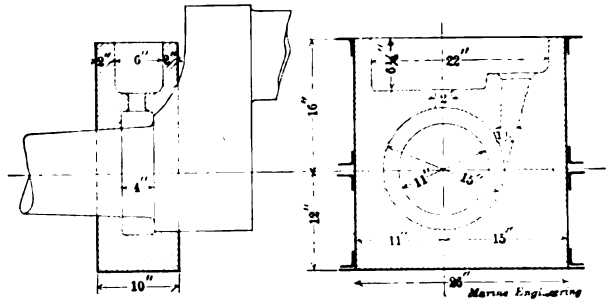
forge, and replacing it. This work would have laid the steamer up for about ten or twelve weeks, and at the cost of from $20,000 to $25,000 altogether.

A space of about 1 1-8 inches was chipped away at the break in order to give the welding iron a chance to run into the fracture, and there was cast around the break a strengthening ring of 2 inches thickness by 6 inches in width, and about 700 pounds of the iron were used in a so-called automatic crucible such as described in October, 1902, number of MARINE ENGINEERING. A mold, consisting of a divided box of sheet iron with a high refractory lining, was placed about the break. The welding was effected after the block had been heated to

BROKEN STERN FRAME WELDED IN PLACE.

a red heat and by allowing the mold to remain in place for four hours. As the amount of metal used in this case was large, the slag was allowed to flow over the rim of the mold into a dry sand bed. The iron in the runner, as well as in the racers, was in one piece with the weld, and it was impossible to break them off even with many blows from sledges and a heavy ram, and they finally had to be cut off with a chisel. As a further proof of the complete welding of the metal, two small holes were drilled through the weld, which showed satisfactory density. Afterward the weld and neighboring parts of the stern frame were annealed for about twenty hours in a hot charcoal fire. The cost of the repair amounted to less than $1,000, and the *Sevilla* has since completed a round trip to Buenos Ayres in good condition.

The second repair referred to was accomplished a few months ago on the paddle steamer belonging to Schurmann Schne, Ruhrort. The repair was made without removing the shaft, and as shown in the illustration. The diameter of the shaft is 13 3-4 inches, and it was broken more than half through. The crack was chiseled open, as in the stern-post repair, and 290 pounds of Thermit iron poured into the mold, a sketch of which

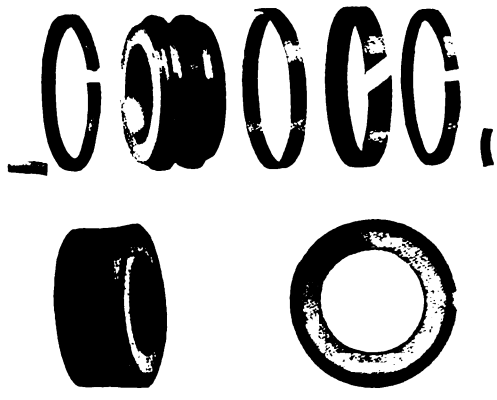


MOLDS USED FOR REPAIRING BROKEN SHAFT.

accompanies this article. The work took but twenty hours, and the steamer has been in regular service since the day after the welding was done. The shaft was *not* thrown out of line as a result of the welding.

Self-Adjusting Packing Ring.

A packing ring which may be used on any form of piston, either water or steam, is here illustrated. It is called the Roberts self-adjusting packing, and consists of six parts in the shape of rings, namely, one bull or jump ring, two steam rings, and one center ring, and two steam joints. The first three named rings are fitted into grooves turned in the bull or jump ring, the center ring being adjusted by a spring which is placed



SELF-ADJUSTING PACKING RINGS, SEPARATE AND ASSEMBLED.

behind it and therefore braces it against the bore of the cylinder. The purpose of this ring is to carry the weight of the piston and to steady the motion. The outer or steam rings are fitted in their respective grooves at each end of the bull ring and constitute the packing. They are readily expanded by the steam pressure to fit the cylinder. Thus, when the piston moves forward the steam fills the groove in the rear outer ring, expand-

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ing it in all directions to the full diameter of the cylinder, and, when the piston returns, the forward outer ring is acted on in the same way by the steam behind it.

Thus it will be seen that but one ring is bearing on the cylinder wall at a time. No oiling is required.

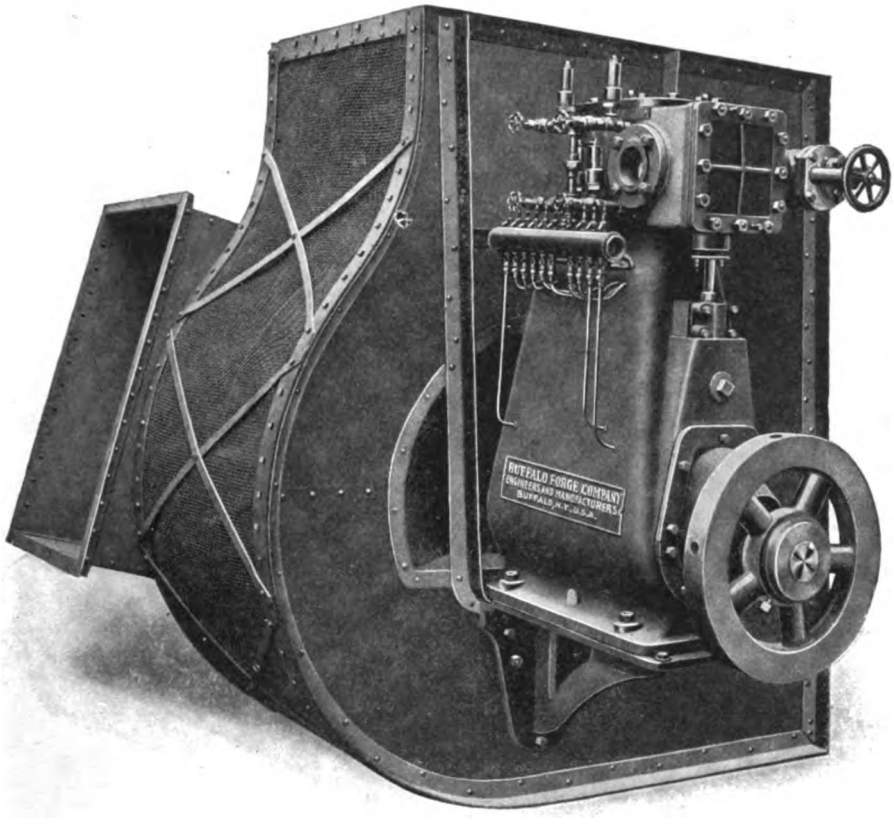
The two steam joints are inseparable parts of the packing, and are fitted in the rib of the bull ring to prevent the steam rings from turning and the steam from passing from one side of the cylinder to the other. The steam rings have a groove into which is dovetailed a tongue; thus these rings may wear down and yet do their work. The steam joints will also prevent rings from falling out in the cylinder.

It is claimed that by the use of this packing the friction of the piston is greatly reduced. Full particulars may be had by addressing the Roberts Steam Piston Packing Company, Bullitt Building, Philadelphia, Pa.

Combined Ventilating and Forced-Draft Fan.

A special and interesting feature in fan building is receiving attention by the Buffalo Forge Company, of Buffalo, N. Y. This is the fan used on board vessels for the double purpose of providing forced draft for the ship's boiler and ventilation for the different parts of the vessel. The conditions of the installation, which are common for similar work, necessitate strong, substantial construction, and the best grade of engine for high speed under continuous use.

Usually for serving these two purposes two distinct fans are necessary, one for furnishing draft for the boiler and the other for ventilation for the ship. The combination fans built for the United States revenue cutter No. 8 are a very good sample of this special type and have proven highly successful. They were two in number, approximately 70 inches high, having a wheel 50 inches in diameter and 22 inches wide at the center, the blades having an easy curve, and made of heavy steel plate securely attached to T-iron spiders, all accurately balanced in cast-iron hubs to secure quiet and easy running without vibration. The side casings were made of heavy steel plate, the ends being constructed of heavy wire screen instead of the usual steel casing. The fans were equipped with Buffalo Forge ring oil bearings with extended shaft for direct connection to a Buffalo 5 by 5-inch double, vertical, double-acting engine with cylinders above the shaft. The engine was of first-class construction and workmanship, being especially specified by Capt. Collins, engineer in chief R. C. S.



FAN USED FOR VENTILATION AND FORCED DRAFT ON SHIPBOARD.

After the construction of the fan and engine the system is very simple. The fan was supplied with a side connection, to which galvanized-iron ducts to different parts of the vessel were attached. Through these ducts the air from the ventilated portions is drawn and blown out through the screen ends, supplying the draft to the boilers.

By using this system the double service is accomplished with the single cost of fans, care, power, and space.

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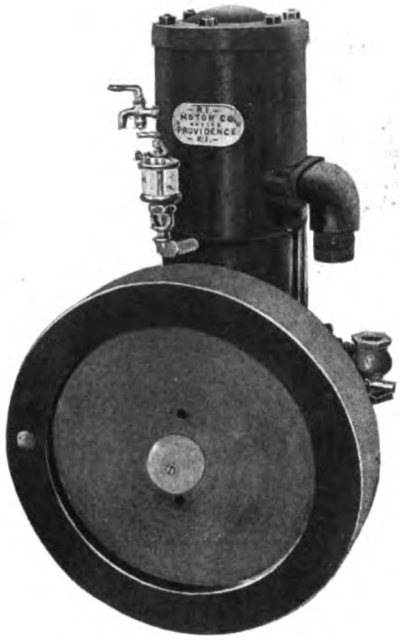
Two-Cycle Gasoline Motor.

Simplicity is the most prominent feature of the Rhode Island motor, as each part is so constructed as to require the least attention. The sparking device is very simple, being regulated by a plug, and the entire mechanism can be removed without taking off the head of the cylinder or breaking any joints or pipes. The electrodes are fitted with platinum bands. The vaporizer is guaranteed to work with the same degree of precision under any conditions of temperature and is of the Lunkenheimer type. The bushings, eccentric straps, and connecting rods are of polished phosphor bronze, thus giving long life, and all parts are made standard and



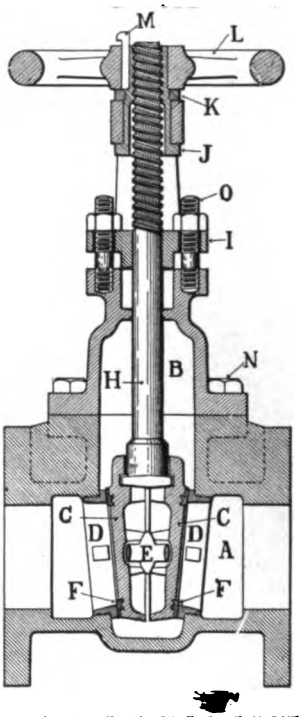
A TWO-CYCLE MARINE ENGINE.

interchangeable. For cleaning out the crank case or adjusting the connecting rod a handhole is placed at either side of the cylinder. A complete system of water-cooling, including the cylinder head and exhaust, is fitted, which will prevent the engine from overheating. The water is circulated by means of a direct-connected pump. A good muffler is fitted on the exhaust, which, while deadening the sound, does not reduce the power of the engine. The pump, eccentric straps, trimmings, and fittings are of phosphor bronze, and, if desired, the cylinder head can be supplied in nickel. The engine is easily started by oscillating the flywheel backward and forward four or five times and at the last turn giving it a swing from right to left, when a spark will occur and the engine be set in motion. As the engine takes but little room and requires but little oil, it is specially adapted for auxiliary work. The maker is the Rhode Island Motor Company, of Providence, R. I.

A New Valve.

A new and original type of gate valve has recently been put on the market which is called the Lenticular double-disk taper-seat gate valve, the word lenticular denoting a double convex form or lens shape, taking its name from the design and shape of the center piece between the two disks.

In this valve there are only four parts which move by the action of the screw: the two disks, the lenticular bearing on center piece, and the stem nut. The disks are provided with recesses or pockets to admit the shoulders or projections cast on the stem nut, and from which the disks are suspended. On the back of each disk is a projection with concave face to fit the convex faces of the center piece, thus making a true center bearing. The construction and relation of the rings on the disks and of the center piece are such that the disks have perfect freedom of movement around the center. The disks are also provided on either side with guide



DOUBLE-DISK TAPER-SEAT GATE VALVE.

wings which work between the guides cast in the body of the valve, and their function is to control the position of the disks when opening or closing the valve. By means of these guides the disks are held in a central position, thus making it impossible for them to come in contact with the seat rings, except at the moment of closing the valve, thereby avoiding all liability to mar or deface them. The center piece has two convex faces, segments of a true sphere, and arranged in a ring form to allow the stem to pass through. The convex faces of the center piece and concave faces of the projection on back of the disk conform to each other, so that when the valve is closed the disks are forced to their seats from the center with an equal, evenly distributed pressure at every point.

This type of valve, which is peculiarly adapted to high-pressure steam service, is made by the Kennedy Valve Manufacturing Company, sales office 63 Beekman street, New York, N. Y., with works at Coxsackie, N. Y.

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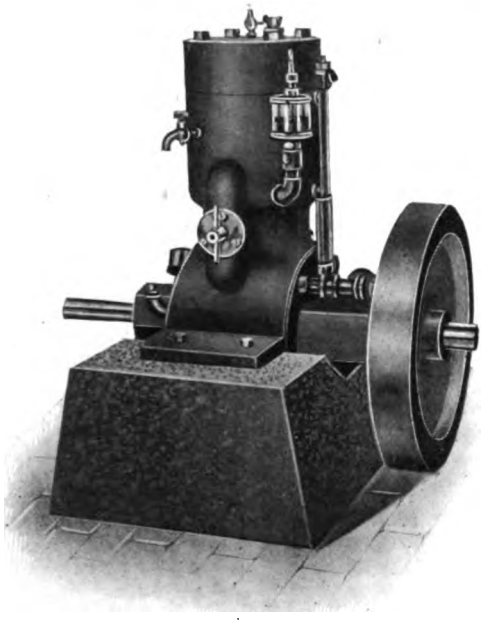
Two-Cycle Gasoline Launch Engine.

A Genesee engine, sold under a two years' guarantee, is herewith illustrated and described. The engine is of the two-cycle type, thus reducing the weight necessary for the same amount of power as compared with a four-cycle engine. The head cylinder and crank case are of separate castings, of close-grained gray iron, and the cylinder is bored and faced. The cylinder is so designed that the burnt gases will pass out through the exhaust before a fresh charge is admitted from the feed port. The connecting rod is of phosphor bronze, constructed so as to take up the wear, and the crank shaft is a well-balanced solid steel forging turned and fitted to long phosphor bronze bushings.

The contact spark with the hammer break is used for igniting the charge. The igniter rod is operated by an eccentric and cam; the downward motion of the rod



TWO-CYCLE GASOLINE ENGINE.

when the cam slips off the eccentric is quickened by a strong spring. A small projection on the rod strikes the movable electrode, thereby making a quick hammer break of the contact. The electrodes are held apart by this projection for the remainder of the stroke and until the rod is moving upward. The electrodes are in contact long enough to insure a good current, but not so long as to rapidly exhaust the batteries. The time of the spark may be adjusted. The current for ignition at starting is supplied by a dry battery of six cells. When under way, by means of a two-point switch the cells are thrown out and the sparking dynamo is thrown in.

Speed regulation is not obtained by throttling the amount of gases admitted to the crank chamber, but by throttling the amount of gases admitted to the firing chamber. This insures a constant mixture at all times. A Lunkenheimer vaporizer is used. Water circulation is supplied by a simple rotary pump; both cylinder and head are jacketed. The engine is made by the Genesee Launch and Power Company, Rochester, N. Y.

QUERIES AND ANSWERS.

Q. 150.—How do you ignite the oil in a fuel-oil burner before getting the proper pressure to eject the oil from the burner; and how do you start an oil burner when there is no burning substance on the fire grate?

A.—With the usual type of fuel-oil burners the pressure required to eject, and atomize or pulverize the oil, is not obtained from the heat developed by the burner, but is provided by an entirely independent source, such as a gravity or pressure feed for the oil combined with a jet or blast of air or steam for the pulverization. This exists quite independently of the fact whether the burner is lighted or not, and it is only necessary to turn on the oil and the blast in order to project the atomized spray from the burner into the furnace.

The easiest method of lighting a fuel-oil burner is to turn on the oil and blast in such proportions as experience may indicate sufficient to give a small atomized spray. A torch is then thrust into the jet, which usually ignites without difficulty.

The combustion of fuel oil is, however, quite imperfect until the temperature in the furnace has risen to a point sufficient to vaporize the oil as it enters and thus produce the necessary conditions for economic combustion. The jet is liable, therefore, at first, to burn irregularly and with a smoky flame, such conditions gradually improving as the temperature of the furnace becomes higher. In some cases where only a few burners are to be lighted, a little wood fire may be built directly in front of the jet and before the latter is turned on. When the fire is well under way the jet may be turned on as before, and the burning wood will serve to vaporize the oil and hold the conditions more steady until it becomes sufficiently hot to vaporize the oil as noted above. Instead of wood a piece of waste soaked in oil may be used, and in any event the torch employed should be one capable of burning for some little time and not readily blown out.

Different burners require different methods for their best operation, but a few trials along the lines indicated should serve to develop the best method in any particular case.

Q. 151.—Will you please give me your opinion of the practical value of a two years' course in naval architecture to a young man who has had four years' experience in yard and drafting room and who intends to make ship construction his life work? Also, what university, in this country or abroad, is in your opinion best adapted for a course of that kind? J. H. H. H.

A.—The value of such a course will naturally depend very much upon the preparation which the student has had, especially in mathematics and such other subjects as will fit him for taking the course with advantage. It should be understood that the purpose of a school or college giving instruction in engineering lines must be to pay first attention to those subjects in which instruction cannot be readily obtained in practical life, or in which suitable training could only be acquired at the expense of a disproportionate effort.

A young man who has had four years' experience in shipyard and drafting room will naturally have acquired a very considerable amount of information regarding ship construction. Much of this, however, will be superficial in character, and he will fail to properly understand the relations between many things which he

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may have observed and the proper dependence of the various parts of the work one upon another. He will naturally have a very imperfect idea of the fundamental principles underlying the work of ship construction, and of the reasons why the work is carried out in one way rather than another. He will find it difficult to act independently, and, in all cases involving design or adaptation, must necessarily be governed chiefly by such examples as may come before him and which may seem to apply to the case in hand.

The chief benefits which such a man may hope to receive from a course of instruction are these:

He may hope to become acquainted with the "reason why," and thus acquire the foundation which, with the aid of suitable judgment, may make of him a designer in the true sense of the word.

He will also acquire a knowledge of the best methods of undertaking the study of the various problems which may present themselves in his daily work, and will thus become fitted to make the best use of such faculties as he may possess.

In order, however, that he may be able to attain these ends it is needful that he should possess some aptitude for mathematics and the mathematical method of studying problems, as well as a capacity for close, accurate, and logical reasoning, based upon such facts as may be presented by the problem in hand. In other words, in order to profit by a course of higher study, he must naturally possess aptitude for such work and for the practice of the higher branches of the profession.

As to whether such a young man can acquire the needed training in two years or not, will depend very much upon the extent of his previous preparation, chiefly in mathematics. Two years is none too long a time to give almost entirely to the study of the science of marine construction; and if a preceding year or more must be taken in work of a preliminary character, obviously the total time should be extended to three years or more. In order to fully profit by a regular course of study in naval architecture and shipbuilding, the student should have a good general education, and in mathematics should be familiar with the subject through calculus. He should also have at least a good elementary knowledge of mechanics, and preferably strength of materials. To the extent to which his preparation may fall below these requirements, to such extent will he require preparatory training, and to a corresponding extent will he fail to receive full benefit from the time devoted to professional subjects.

Having in view the scientific character of the development along all engineering lines during the past few years, it is clear that no one who intends to make ship construction a life work should deprive himself of such advantages as may come to him through a course of theoretical training, the best which his circumstances will allow him to obtain.

Special instruction is given in such branches at Cornell University, at the Massachusetts Institute of Technology, at the University of Michigan, and at the Webb School, Fordham Heights, New York. Correspondence with these institutions should enable the student to judge for himself as to which is most likely to furnish the instruction best suited to his particular needs.

Q. 152.—Will you kindly answer through the columns of your paper the following questions:

1. With a new vessel on the ways, how would you put in the stern tube and pipe?

2. State in detail and rotation what parts of engine and machinery you would place in the vessel.

3. With engine 50 inches diameter of cylinder by 5 feet stroke, steam 100 pounds, how would you find, without the use of an indicator, the mean effective pressure and the amount of water in cubic inches it would require to make this amount of steam (engine to cut off at half-stroke)? W. A. K.

A.—(1) and (2) Questions of this character can rarely be answered satisfactorily. They are questions of practice and vary widely in treatment, according to the particular ideas of the engineer in charge of the work. With regard to the stern tube, the question of putting it in we may suppose to refer to the method of lining up the boring bar and thus locating the tube. As for putting it in place, no practical man will have any especial difficulty once the ship is bored out and made ready.

Regarding the location of the boring bar the following principles should be borne in mind, and if clearly understood they may be fulfilled in the manner best adapted to the case in hand. In the first place the drawings will locate the center line of the shaft. In any event the after end of this line must be located practically at the center of the boss aperture left in the stern post. Measurement from the drawing will serve to locate likewise the center line at the after bulkhead or forward end of the tube. The problem then becomes one simply of setting up a boring bar in the line thus determined. This may usually be done most readily by locating the center line just at the points where the ends of the bar will come, marking them by cross wires or in any other convenient manner, and then adjusting the bar so that its centers correspond to these points. If it is remembered that the problem involves simply the transfer of a line from a drawing to a ship and the setting up of a boring bar in that line, a suitable mode of practical operation should be found without serious difficulty.

Regarding the installation of the engine there is no necessary order of parts which must be followed as a hard and fast rule. Very generally the engine-room auxiliaries should go in first, so as to make sure that no difficulty will be experienced in getting them in after the engines are placed. Then, naturally, the bed plate and crank shaft come first, then the columns, next the cylinders, and then the various other parts as may be convenient. Very commonly the shafting should all be installed before the columns and cylinders are set up, in order to have plenty of room for handling long and awkward pieces down through the engine hatchway. Here again common-sense is worth more than any amount of academic discussion, and the practical man who knows what a marine engine is and how it looks when set up in a ship will not be troubled over the order in which he should take the various parts.

(3) The question as framed seems to refer to a simple engine and to the admission of steam at 100 pounds gage pressure to the cylinder with dimensions as stated. With cut-off at half stroke the expansion, including the effect of clearance, will be found as follows: Assume the clearance 12 per cent.—and it can scarcely be less in ordinary marine practice—then the total volume at the

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end of the stroke will be cylinder plus clearance, and this will be represented by 1.12. Similarly the total volume at cut-off will be one-half cylinder plus clearance, and this will be represented by .62. The quotient of these will be 1.806, and this will be the expansion ratio. Then the mean forward pressure will be found by the formula:

$$p = p_1\left(\frac{1 + \text{hyp. log. } r}{r}\right)$$

where p_1 is the absolute pressure at the engine and r is the number of expansions. From a table of hyperbolic logarithms we find in this case:

$$p = 115\left(\frac{1 + .59}{1.806}\right) = 101.2.$$

If then we assume that this is a condensing engine the back pressure may be taken at 3 pounds. This will leave 98.2 as the mean effective pressure, with no allowance for the rounding off of corners, loss by compression, etc. The extent of this loss can only be estimated, but in a single cylinder it should not exceed 10 or 15 per cent. This would give as the mean effective pressure from 83 to 88 pounds with a *condensing* engine and under the conditions specified.

This computation gives simply an estimate of the probable mean effective pressure. The indicator alone can give the actual value. It may be noted that the conditions assumed in this question as it is worded are not met with in marine practice with engines of this size.

In the latter part of the question it seems to be assumed that the amount of the steam is measured by the mean effective pressure. This is entirely erroneous. The only way in which the question can be answered is to find the amount required to fill the cylinder once up to the point of cut-off. To this end we find the volume, which is 58.905 cubic inches. At 100 pounds gage pressure the relative volumes of water and steam are as 1 to 241. Hence the corresponding volume of water will be $58.905 \div 241 = 244$ cubic inches, or about 8.8 pounds. This would be the amount were there no cylinder condensation. Actually a part of the steam would be condensed as it enters the cylinder and comes in contact with the relatively cooler surfaces. In such a case as that here assumed the amount thus condensed might readily be 20 or 30 per cent. of the whole, and we should therefore expect that not less than 10 or 11 pounds per stroke or 20 to 22 pounds per revolution would be required to supply the engine in question.

Towing on Erie Canal.—The subject of towing by electricity on the Erie canal has again been brought up in view of the successful experiments in this line in Belgium and in other countries. There are several systems of towing, and that which seems to be best adapted for canal purposes, where the speed of the boat is largely limited by the wash and waves made, is that of an overhead trolley cable. The motor runs on a cable directly over the canal and is supplied with electricity from a second wire. Another system is that of having a traction engine running along the towpath and operated by electricity received from an overhead trolley.

TECHNICAL PUBLICATIONS.

The Resistance and Power of Steamships. By W. H. Atherton and A. L. Mellanby. Size 5 by 7 inches. Pp. 196, with numerous cuts and diagrams. Technical Publishing Company, Manchester, England. Price five shillings.

The subject matter of this book appeared first in the form of occasional articles published in *The Practical Engineer* and written chiefly by the first-named author. The various recognized methods of determining the engine power required to propel steamships are discussed in detail, and examples of their application are given. The subject of fouling is also discussed in detail, on account of its important influence on the actual resistance of seagoing ships. The purpose of the authors has been to present this general subject matter in such manner as will appeal to marine engineers and shipbuilders, and to those in general who are interested in the development of modern marine construction.

The work in general seems to have been carefully done, and, in accordance with the apparent purpose of the authors, consists in a compilation and presentation of the various methods which they may have deemed of interest or value. The authors have not always been able to escape the influence of a great name or of fashion in the past. Thus Rankine's augmented surface method is given with all the minutiæ which might have been considered appropriate forty years ago, and as though the augmented surface when computed were of some particular value, or the theory on which its application was based were of some present-day use. Similarly, Scott-Russell's rules for the length of fore body and after body are given as though they might be followed at the present day. As a further instance of this, mention may be made of Kirk's analysis, and of the value of the wetted surface which thereby results. It is well known that as a method of computing wetted surface this method of using a substituted block is quite inaccurate, and is distinctly inferior to several empirical formulæ vastly simpler and quicker in application. As a method of aiding in comparing ships the block models may have a use, but not advantageously for the computation of wetted surface. The name and justly high reputation of Dr. Kirk have led his followers to give to these methods more importance than their author would probably have been inclined to give himself.

In an historical discussion of the development of ideas regarding ship resistance and power, all such methods should find their full explanation. In a presentation of the best and latest word of modern research on these matters, however, an author is hampered by sticking too closely to the historical landmarks.

The treatment of the law of comparison is clear on the whole, but a more definite statement of its foundation and real significance would have been useful. The Admiralty formula is discussed and its relation to the law of comparison brought out. This discussion, as a whole, is scattered through parts of different chapters, and a more unified treatment would have put the matter in a form somewhat more readily grasped.

The matter relating to fouling and the consequent increase of resistance forms one of the most interesting

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sections of the book, and is the more acceptable as such matters are not commonly treated with so great detail under the general subject title of the book.

As a whole the book will prove of interest and value in a simple and practical way to many who have to deal with problems of ship resistance and powering. It will be of but small value, however, to those who may wish to acquire any really thorough understanding of the topics considered, especially in their wider aspects and independent of the particular problems with which they may be associated.

The Gas Engine Handbook. By E. W. Roberts, M.E. Fourth edition. Size 3 1-2 by 5 inches. Pp. 254, with numerous illustrations. Gas Engine Publishing Company, Cincinnati. Price $1.50.

This little handbook, published first in 1900, has met with such success that it has rapidly passed through successive editions. In the preface to the present and fourth edition the author calls attention to the additional matter on automobile engine design, on the power factor as a means of comparing the performances of gas engines. on the two-cycle type of engine, and on screw propellers for small boats. On the latter topic the methods given can hardly be considered satisfactory for propeller design. The statement is made that for large vessels the pitch of the propeller is usually 1.3 times the diameter, while for smaller craft the ratio is from 1.6 to 1.8, and that a propeller 30 inches diameter is usually given a pitch of 51 inches.

It is true that for large ships, and smaller ones, too, for that matter, the pitch ratio is often in the neighborhood of 1.3. The idea should not be gained, however, that there is anything binding in regards this ratio. As a matter of fact the pitch ratios of large propellers are found from 1.0 to 1.5, and naturally many will be found about 1.3, which is near the middle of the range.

For small boats the pitch ratio is often found from 1.3 to 1.8 or more, depending largely on the desired speed and revolutions of the engine. With electric launches, however, the pitch ratio is very small, usually about 1, or less. The pitch ratio should not be selected independently in the manner suggested, but should result from a proper relation between the desired speed, power, and other conditions of operation.

For determining the diameter of the propeller the rule given provides for a disk area 40 per cent. of the immersed midship section of the boat. This will give fair results if experience is available for determining the other features. For high-powered boats, however, the ratio should be somewhat higher. This topic is, however, only incidental to the main purpose of the book. With the general subject of gas engines, their design, construction, and operation, the author is thoroughly at home, and is an acknowledged expert in this general field of engineering work. The book covers the field of modern gas-engine design and construction, more especially as utilized for motor boats and vehicles, and in a clear and instructive style. The additional matter on automobile practice should be very acceptable to those interested in this field of application for the gas engine, and in its latest revision the book will deserve and doubtless receive a continuance of the high favor which has attended its appearance in earlier editions.

The Shipbuilding Industry in Germany and in Other Countries. By Tjard Schwarz and Dr. Ernst von Halle. Vols. I. and II. Size 7 by 10 inches, pp. 604, with charts and folding plates. Berlin, Ernst Siegfried Mittler and Sohn. Price 20 marks.

In 1899 a German government commission was ordered to make a careful examination of the development of facilities for shipbuilding in the various German shipyards. The scope of this examination was later extended to cover the chief maritime countries outside of Germany. This research gave such a rich store of materials as to justify the publication of such parts as might prove of especial interest or value to the industrial world. The authors of the present work were therefore entrusted with the editing and preparation of the matter for such publication, and we have the result in the two volumes under notice.

The first volume deals more especially with shipbuilding in countries other than Germany, and the second with the condition of the art in Germany.

The titles of some of the more important chapters will serve to show the scope and character of treatment. Such are: The technical development of shipbuilding in the nineteenth century; the numerical development of the world's merchant fleet since 1815; the principal legislation relative to shipbuilding in the nineteenth century; the development and organization of the chief shipyards in England, America, France, and Germany; ship classification societies; quality of the materials of construction for ships and marine machinery; establishments for model experiments; the principal educational establishments where instruction in marine construction is given; historical development of German shipbuilding; detailed organization of the chief shipbuilding yards in Germany.

Taken as a whole, this work is of the greatest value and interest as the first comprehensive view of the world's shipbuilding industry which has appeared since the art took on its modern form. The members of the commission, among whom were the authors, enjoyed the widest opportunities for gathering material for such a work, and with characteristic national thoroughness they have made the most of their opportunities. From this mass of material the authors have made wise selection, and give a view of the present condition of the art which should prove of the highest value to all who are concerned with ships and shipping. It is to be regretted that no translation into English has been made, so that the usefulness of the work might be more readily extended in the United States and Great Britain.

Life and Adventures of "Jack" Philip, Rear-Admiral, U. S. N. By Edgar S. Maclay, A.M., and Barrett Philip. In 4 volumes. Price 25 cents each. Size 7 by 10 inches. First volume pp. 80, with 6 illustrations. The Illustrated Navy, 13 Astor place, New York, N. Y.

The first volume of the life and adventures of "Jack" Philip has been published in the form of a magazine, and will include four numbers. The introduction is written by Captain A. T. Mahan, U.S.N., and Rear-Admiral Balch, U.S.N., and Mrs. Mary Philip Wheelock, sister of Admiral Philip, have also contributed articles. The story of Captain Philip's life is written by Edgar S. Maclay, A.M., and is interspersed with extracts from Captain Philip's diary. Few officers in the United States navy have had a career so nearly ideal as that of Captain Philip. His

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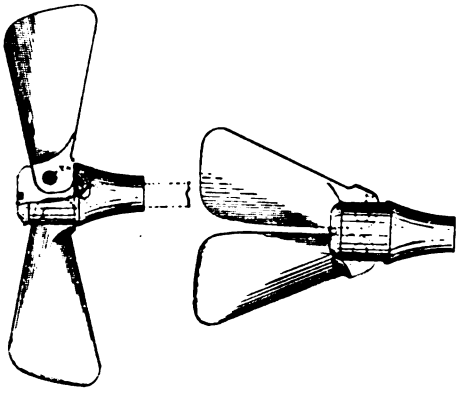
long devotion to duty, his conscientious carrying on of routine, his superb conduct in battle, modesty, generosity, and splendid character, have more than endeared him to the American people. After the untimely death of Rear-Admiral Philip, known as "Jack" Philip by all of those close to him, it was found that he left practically nothing to support his family, and his friends have taken this means of raising funds. The first number of the magazine is indeed attractive and it is promised by the publishers that the three succeeding numbers will be equally so. All those interested in our navy will appreciate this book, which covers the periods of the Civil War and the reconstruction.

The American Power Boat Association Year Book, 1903. Size 4 1-4 by 5 1-2 inches. Pp. 46. Rudder Publishing Company, 9 Murray street, New York, N. Y. Price 25 cents.

The racing rules, articles of association, time allowance tables, etc., of the American Power Boat Association are given in a compact size pamphlet, and will be found of very great value to owners of power boats. Until this association was recently formed there was no standard of rules for racing power boats. The object of the association, as stated in the articles, shall be to promote the use of power boats and the improvement of their design and power construction, and to formulate rules to cover the trials of speed and endurance between such boats. In following out this worthy object the organizers have well covered the classification of different boats and worked out tables of time allowance for use in rating boats. Under the direction of this organization it is to be hoped that the power-boat races may be systematized and that there will be some uniformity in the general design of such boats.

SELECTED MARINE PATENTS.

725,097. PROPELLER. ARTHUR W. LEARNARD, BOSTON, MASS.



Claim.—1. In a propeller of the character described, a hub or head adapted to be rigidly secured to the shaft; and blades pivotally secured at their inner ends to the hub or head and adapted by their shape to spread or swing outwardly therefrom and act as propeller blades when the shaft is rotated in the ordinary direction, and to fold inward toward each other when the shaft is reversed or the vessel is drawn through the water by sail or other power not connected with the propeller shaft. Four claims.

725,137. AIR-EJECTING APPARATUS FOR VESSELS. GUSTAVE QUANONNE, HOUDENG-GOEGNIES, BELGIUM.

Claim.—1. In a ship, in combination with blowing apparatus designed to facilitate her progress, and with air distributers fed from said apparatus, means for counteracting the outward obstruction of the air outlets, and means for preventing the bursting of the pipes in case of excessive air pressure. Six claims.

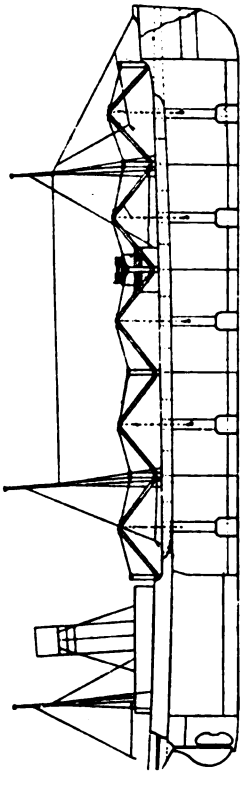
725,202. METHOD OF FORMING NAVIGABLE CHANNELS. LINDON W. BATES, CHICAGO, ILL.

Claim.—1. The herein-described method of forming channels in river bars and the like, which consists in eroding the material of the bar in a groove or channel extending across the entire length of the bar, and keeping the eroded material in suspension, whereby said material will be carried downstream through said groove or channel by the current of the river. Six claims.

725,203. APPARATUS FOR FORMING NAVIGABLE CHANNELS. LINDON W. BATES, CHICAGO, ILL.

Claim.—1. In an apparatus for forming channels in river bars and the like, the combination of a line of flexibly-connected pontoons extending across substantially the entire width of the bar; means for reciprocating said pontoons across the surface of the bar and maintaining them in their various adjusted positions; and eroding devices for the surface of the bar carried by said pontoons. Two claims.

725,219. CARGO-TRANSPORT VESSEL. WILLIAM G. CLARK, WATERLOO, NEAR LIVERPOOL, ENGLAND.



Claim.—1. A cargo-transport vessel having its hull divided into a plurality of holds by athwartship bulkheads; tunnels at the lower part of the holds, and extending transversely therein; vertical shafts extending between the deck above the holds and the upper part of the tunnel; a continuous hatch disposed on either side of the center line of the ship, raised on and standing above same, into which the upper ends of the said shafts enter, and to which they are connected.

2. A cargo-transport vessel having its hull divided into a plurality of holds by athwartship bulkheads; a tunnel at the lower part of the holds, extending across same laterally; a vertical shaft extending from the tunnel up to the deck; and an endless conveyer on the floor of the hold, extending between the interior of said holds and the interior of the tunnel. Six claims.

725,264. FLOAT ARRANGEMENT FOR BOATS. WILHELM M. VON MALEIN, HAMBURG, GERMANY.

Claim.—1. The combination of a boat with a vertical pivot at each side of the boat, an outrigger rotatably mounted on each pivot, and float bodies rotatably mounted in the free ends of the said outriggers. Three claims.

725,280. SHIP'S PROPELLER. GEORGE R. NOBLET, PARADISE, OKLA.

Claim.—1. A propeller comprising a casing having a shaft disposed centrally thereof, a wheel on the shaft having a diameter substantially the same as the casing, and a helical blade secured to the shaft in the rear of the wheel and having its diameter increasing gradually in the direction of its rear end. One claim.

725,399. COMPASS ATTACHMENT. JOHN L. BLISS, NEW YORK, N. Y.

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Claim.—1. The combination with the glass plate of a compass box provided with a socket in its upper face, of a compass attachment for determining the compass position of the sun, the said attachment comprising a bracket provided with a projection for entering the socket in the glass plate of the compass box to center the bracket with respect to the compass plate, a thread extending from the base to the head of the bracket, and means for permitting the adjustment of the thread to render it taut. Three claims.

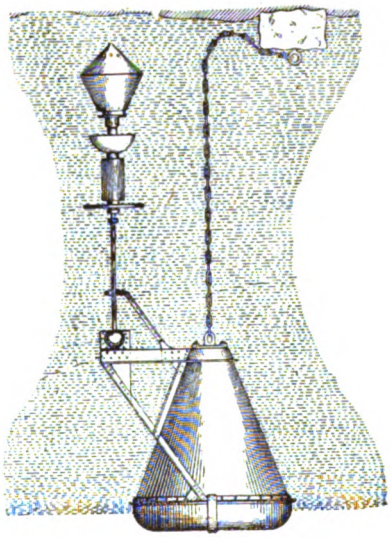
725,570. OBSERVING TUBE FOR SUBMARINE BOATS. SIMON LAKE, BRIDGEPORT, CONN.

Claim.—1. The combination with a submarine boat, of an observing tube passing through the wall of the same and surrounded by a stuffing box by which it is held rigidly in upright position, but is permitted to slide outwardly and inwardly and to be revolved in respect of said boat, a mirror or reflector in the upper or outer end of said tube adapted to receive laterally an image of an external object and to reflect it downwardly through said tube, and means for raising and lowering said tube through its surrounding stuffing box. Two claims.

725,639. PROPELLER WHEEL. CHARLES L. WEBBER, NEENAH, WIS.

Claim.—1. A propeller wheel having a plurality of blades arranged at a suitable angle with its axis around its hub, each blade consisting, upon its side for acting upon the water for propelling a vessel forward, of a flat plate of metal of polygonal form, the contour of its forward or entering edge being of an obtuse angular form, the outer end of the blade being an acute angle which lies in that plane of rotation of the wheel which passes through the shank of the blade, and the rear edge of the blade having a nearly right angle and an obtuse re-entering angle. Six claims.

725,755. AUTOMATIC MEANS FOR PRODUCING SOUND VIBRATIONS IN WATER. ARTHUR J. MUNDY, BOSTON, MASS.



Claim.—1. A submerged automatic sound-producing signaling device for imparting sound vibrations to water by which they are conducted, means operated by the water for actuating the device comprising a buoyant support by which the device is suspended in the water, and an interposed mechanism between it and the sound-producing device whereby a change in the relation of the two produced by movement of the water will cause the sound-producing device to be actuated. Six claims.

725,839. APPARATUS FOR FACILITATING THE SIGHTING OF DISTANT OBJECTS FROM SUBMARINE BOATS, BARBETTES, ETC. HOWARD GRUBB, DUBLIN, IRELAND. Four claims.

725,887. TIDE-WATER APPARATUS. HENRY SMETANA, NEW YORK, N. Y., ASSIGNOR TO INTERNATIONAL TIDE POWER COMPANY, A CORPORATION OF NEW YORK. Three claims.

726,085. SUBMARINE BOAT. HARRY H. MORRELL, NEW SUFFOLK, N. Y.

Claim.—1. A submarine boat having an escape opening directly into the water when the boat is submerged, and local means in the boat for receiving the water passing through the escape, the said means serving to retain the water and thereby form a breathing space adjacent to the escape. Seven claims.

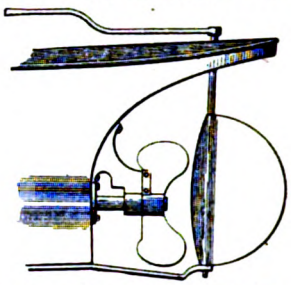
726,118. DEVICE FOR INDICATING POSITION OF SUNKEN SHIPS. ANDREAS TOMIC, PITTSBURG, PA. Two claims.

726,227. SUBMARINE BOAT. SIMON LAKE, BRIDGEPORT, CONN.

Claim.—1. The combination with the hull of a submarine boat, of a normally closed superstructure covering the upper portion of the same, means for admitting water to said superstructure, a discharge pipe extending from the bottom of said superstructure to the top of the same, and provided with a normally open inwardly-closing check valve, and means for admitting air under pressure to said superstructure to expel the water through said discharge pipe.

2. The combination with the hull of a submarine boat, of a normally closed superstructure covering the upper portion of the same, of which the deck is higher along the center than at the edges, means for admitting water to said superstructure, and an air pipe leading outwardly from the higher portion of said superstructure. Two claims.

726,180. WEED CUTTER FOR THE PROPELLERS OF LAUNCHES. LUDVIC M. MILLER, WINNECONNE, WIS.



Claim.—1. In a weed cutter for launches, the combination of a weed guide attached to the hull and provided at its rear with a cutting edge, a screw or propeller having cutting edges which move in close proximity with the cutting edge of the weed guide. Three claims.

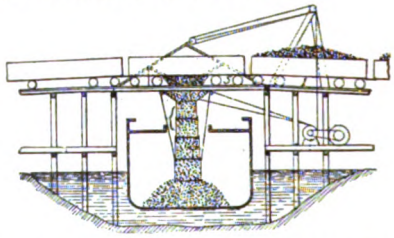
726,268. PILE DRIVER. FREDERICK A. VON EBERSTEIN, SAVANNAH, GA. Three claims.

726,647. MARINE-ENGINE GOVERNOR. PETER V. CORNILS, SEATTLE, WASH.

Claim.—1. A marine-engine governor comprising a compressed-air reservoir, a counterbalancing cylinder containing a piston and connected at one end with the said reservoir, the other end being filled with a liquid, a water-pressure cylinder in the side of the vessel, opening into the water in which the marine vessel is afloat, a piston in the water-pressure cylinder, connected with the piston in the said counterbalancing cylinder, an actuating cylinder containing a piston and connected with the end of the said counterbalancing cylinder containing the liquid, and means connecting the piston in the actuating cylinder with the throttle valve of the engine. Five claims.

726,733. TIDE MOTOR. PATRICK J. NEVINS, HAVERHILL, MASS. Two claims.

726,685. APPARATUS FOR LOADING VESSELS. ELLIOT HOLBROOK, KANSAS CITY, MO.



Claim.—1. In an apparatus for loading vessels, the combination with a fxed track or way, of a movable bridge or platform having a track or way adapted to align with the fixed track or way and to receive a series of coupled cars, a discharge opening intermediate of the ends of the movable bridge, means for moving the bridge or platform into place over a vessel and with the track or way thereon in alignment with the fixed track or way, whereby loaded cars may be run upon the bridge from the fixed track or way and the load discharged in succession directly into the vessel without uncoupling. Five claims.

726,705. SUBMARINE BOAT. SIMON LAKE, BRIDGEPORT, CONN. Six claims.

Government Ships.—It is reported that the only two government ships under construction which are not behind in their assumed percentage of completion are the battleships *Louisiana* and *Connecticut*. The former is being built at Newport News, Va., and the latter at the Brooklyn Navy Yard.

Institution of Naval Architects.—The summer meeting of the Institution of Naval Architects will be held in Ireland during the last week of June. It is proposed to spend the 23d and 24th of June in Belfast and the 25th and 26th in Dublin. Local committees are preparing an interesting programme for members and visitors. Among the works to be visited are those of Messrs. Harland and Wolff and Messrs. Workman and Clark.

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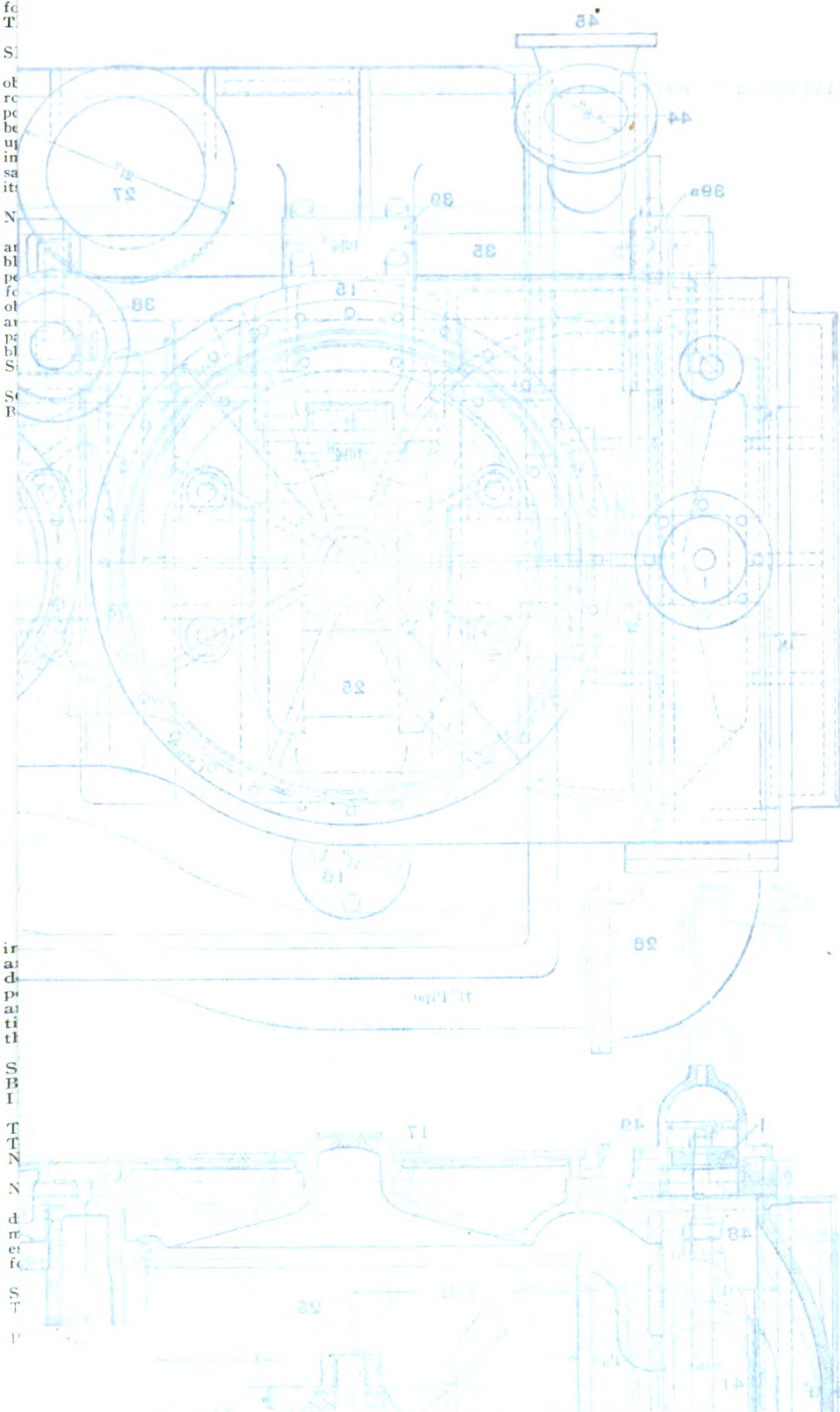

osing check valve, and means for admitting air Harland and Wolff and Messrs. Workman and Clark.

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Marine Engineering

Vol. VIII. NEW YORK, JULY, 1903. No. 7.

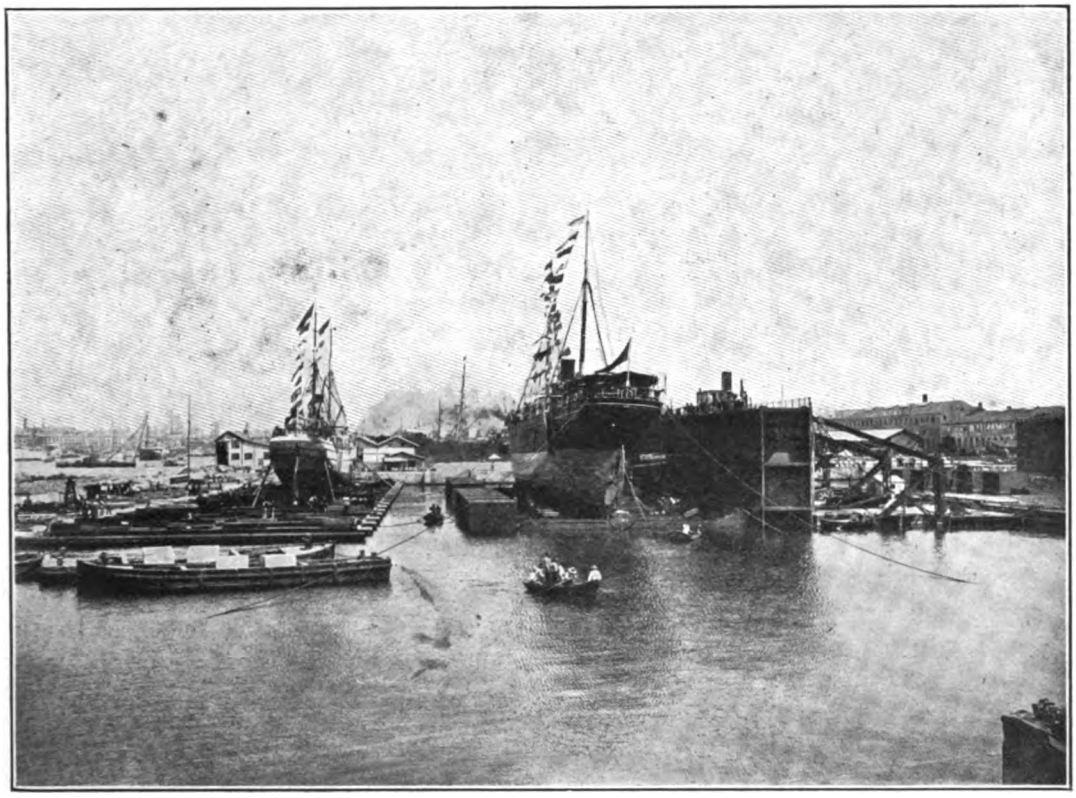
THE BARCELONA DEPOSITING DOCK.

In view of the importance of Barcelona as practically the center of Spain's commercial life, it is surprising to find that it has only recently been provided by the port authorities with a dock capable of dealing with the many thousands of tons of shipping frequenting the port annually. After considerable discussion by the harbor board on the merits of various forms of docks laid before them, they finally decided on adopting the design of Messrs. Clark and Standfield, of London, which provided for a depositing floating dock, which, as shown by the following description and illustrations, is an ingenious combination of pontoons and staging, completing an arrangement which enables several vessels to be repaired at the same time.

The dock is of the single-sided type, attached by hinged booms to a floating outrigger; but instead of the pontoon or platform being a continuous caisson, it is divided up into separate fingers, each attached to the wall of the dock. Similar fingers to correspond with the spaces between the dock fingers, and built up of piles, are erected along the fore shore, and when the vessel has been raised on the dock the whole dock with the vessel on it is warped in between the fingers on to the grid. The dock is then lowered, the vessel remaining deposited high and dry on the grid, and the dock then withdrawn, ready to pick up and deposit other ships if required.

It will be seen, therefore, that the construction of each grid of the same length as the dock is equivalent to doubling the capacity of the dock, and, if space is available, this forms a very cheap way of obtaining a large amount of docking accommodation. Of course, where only one vessel requires docking, the dock can be used as an ordinary floating dock, without the use of the depositing staging.

Such a dock is especially adapted to the port of Barcelona, first, because of the absence of the tide, which enables the dock to deposit vessels at all hours, and, second, because there being no dock of any kind in



BARCELONA DEPOSITING DRY-DOCK, SHOWING ONE VESSEL ON THE GRID AND ANOTHER ON THE DRY-DOCK.

(Copyright, 1902, by Marine Engineering, Inc., New York.)

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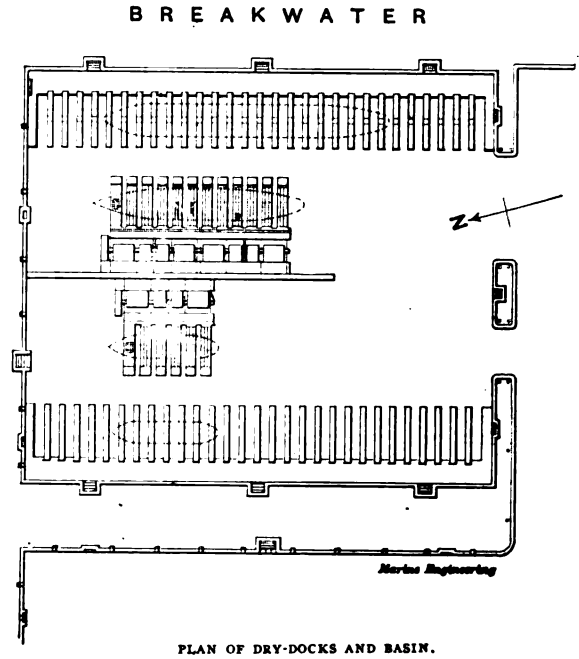
Barcelona, which is a large shipping port, there is far more work than could be handled by a single dock. One of the projects considered was for three dry-docks, the cost of a single one of which would have been more than this depositing dock, which has a lifting power of 6,000 tons. The dock works normally in two sections, which are arranged so as to lift vessels displacing 4,000 and 2,000 tons respectively. There is also a hinged joint by which these two sections can be coupled together in fifteen minutes, so as to lift a ship of 6,000 tons. The largest section is also divided into two equal parts connected by a bolted joint, which can be unmade to allow the two parts to be used to lift one another for self-docking; while of course the smaller section can be docked on the larger, thus enabling any part of the whole dock to be got at for the purposes of repair.

On the next page is shown how one section of the dock may be lifted by another section. This self-docking system is one of the distinctive characteristics of the different types of floating docks turned out by the designers. It naturally allows the life of the structure to be indefinitely prolonged, and if carefully looked after may be considered as lasting as a graving dock.

The machinery for working the dock is designed to lift a ship of the maximum weight in 1 1-2 hours, and was constructed by the builders of the hull of the dock, namely, the Maquinista Terrestre y Maritima of Barcelona. There are also provided on the sections hauling engines and gear for moving the dock back and forth to the grid.

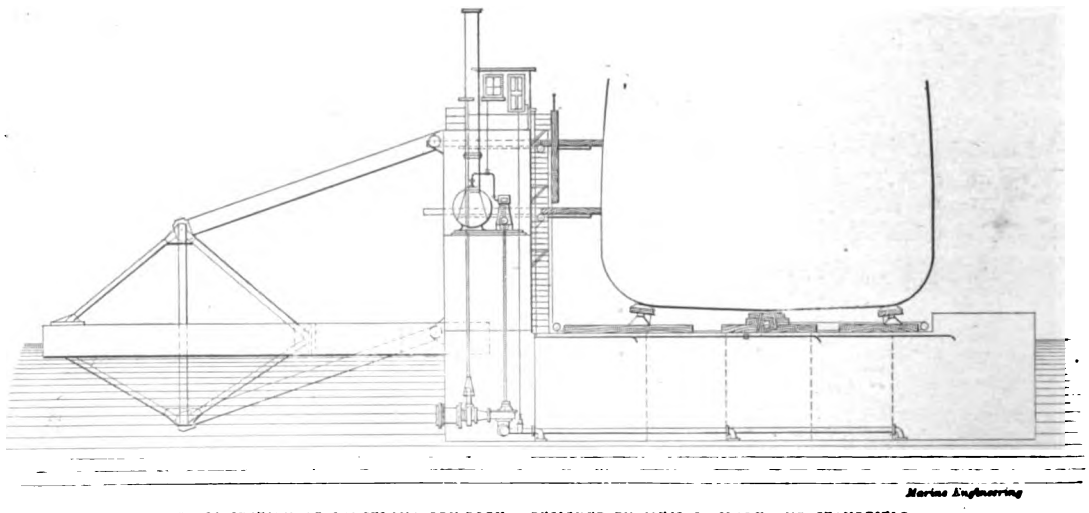
other suitable for vessels up to 6,000 tons. Thus the docking capacity in numbers and length of vessels may



PLAN OF DRY-DOCKS AND BASIN.

be considered to be equal to the length of the grids plus the length of the dock.

A comparative novelty has been fitted to this dock,



CROSS SECTION OF BARCELONA DRY-DOCK. DESIGNED BY MESSRS. CLARK AND STANDFIELD.

At the recent official trials in January last the *Ciudad Condal*, one of the fleet of the Compania Transatlantica, was successfully lifted and deposited, this trial being particularly gratifying in view of the fact that this vessel was over 40 feet longer than the section of the dock by which it was lifted and deposited.

As installed at Barcelona, the two sections are placed in the middle of the basin, back to back with the third section. On each side of the basin opposite the docks are two grids, each 650 feet long, the one built to take light vessels up to 2,000 tons displacement, and the

which proved of the greatest use in depositing vessels: this consists of indicators connected with each of the compartments of the dock, showing in the valve house the exact height of water in every compartment.

The length of the whole dock is 350 feet, that of each section being 120 feet, and the width of entrance 75 feet, although the dock being a single-sided one this dimension is not the absolute maximum.

At Barrow, in England, and Vladivostok and Nocolaiev, in Russia, similar docks by the same designers have proved conspicuously successful for many years past.

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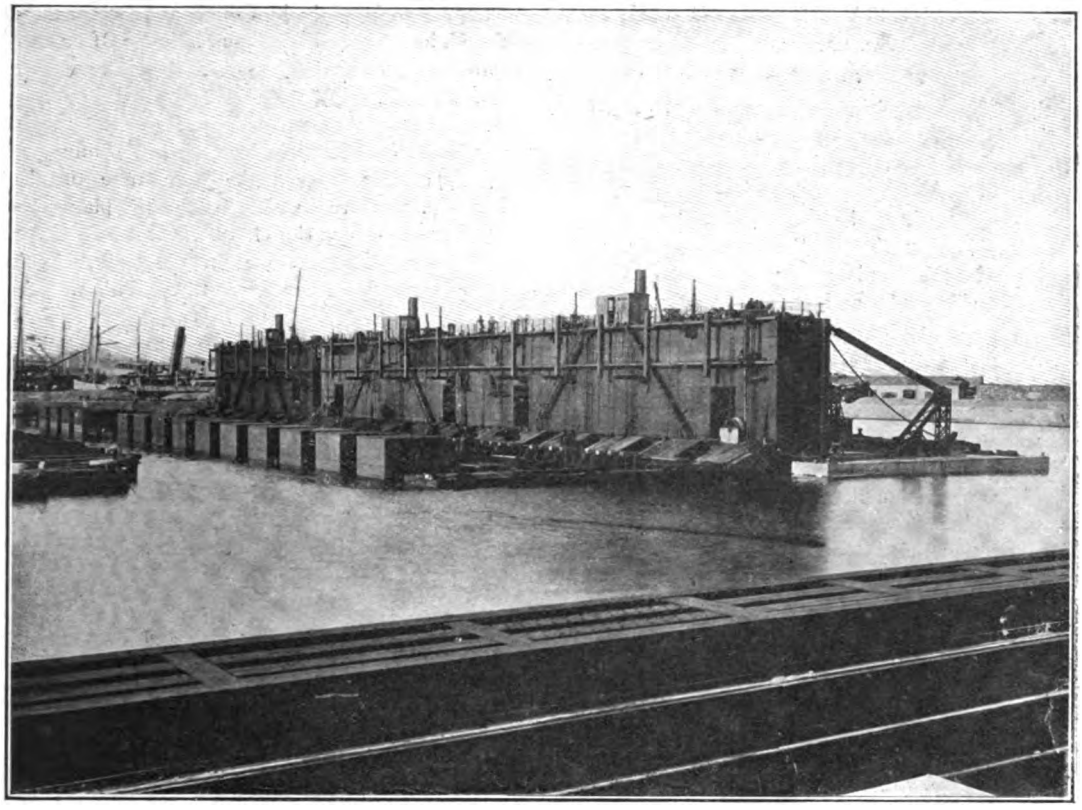
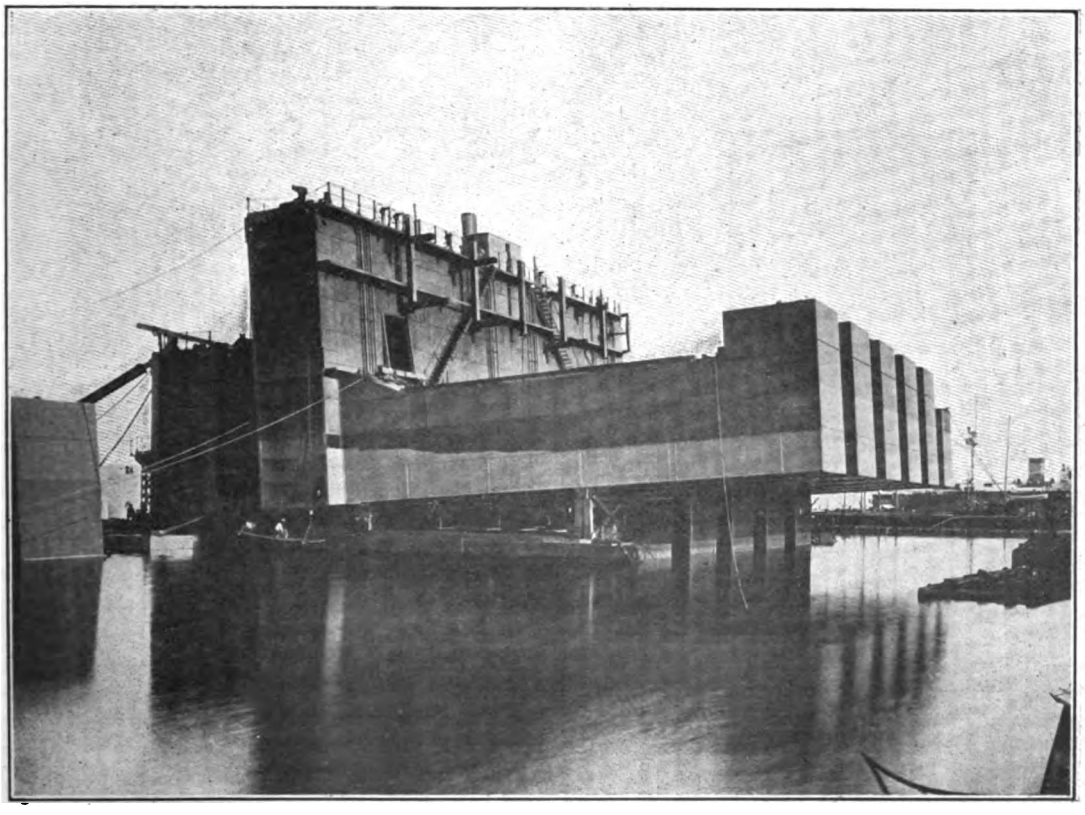


GENERAL VIEW OF DRY-DOCK.



BARCELONA DRY-DOCK, ONE SECTION BEING DOCKED BY A SECOND SECTION.

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USES OF ELECTRICITY ON BOARD SHIP.—I.

BY J. W. KELLOGG.

EARLY INSTALLATIONS.

Since the first installation of incandescent electric lights their adaptability for ship use has been apparent, and as the applications of electricity have been extended it is shown to be ideal for transmission of energy for all purposes on shipboard. It is interesting to follow this development. The first electric plant that was ever put into operation in the hands of strangers was on the steamship *Columbia*, and was installed under directions from Mr. Edison. In a report dated February 24, 1882, Mr. J. C. Henderson, who was at that time advising engineer of the Oregon Railway and Navigation Company, states that in the summer of 1879, while the *Columbia* was under construction, he wired the ship for electric lights; the plant was started on the 2d of May, 1880. There were 115 lamps installed, and No. 11 wire was used for mains and No. 32 wire for the loops, insulated by double-paraffined cotton, and painted over all. The report states that the wires were run throughout the entire vessel, but lights were only placed in the passengers' rooms and the main saloon. The engineer of the vessel stated that 115 lamps were operated over four hundred hours without one lamp giving out. Two years after the plant was started it was reported that from the time of starting until that day the plant had operated to the entire satisfaction of the company under all circumstances.

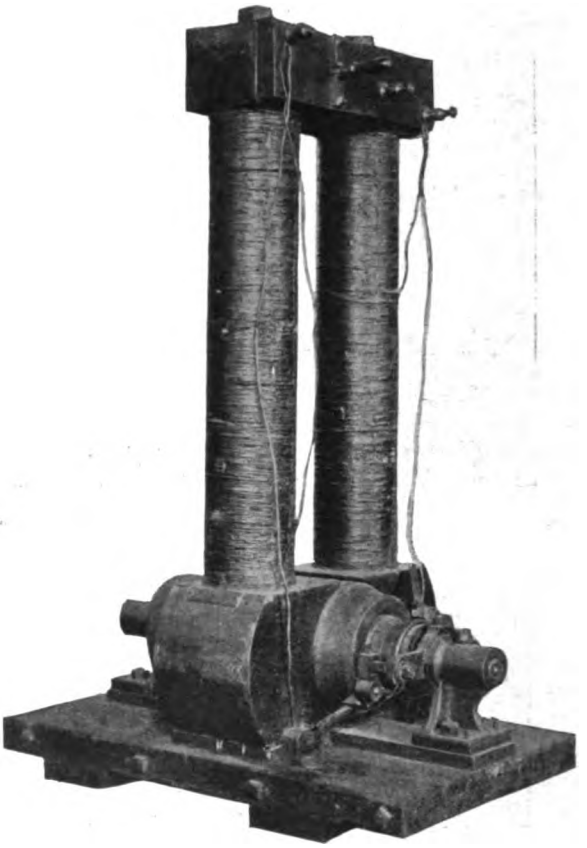
From 1880 to 1882 there was very little done in steamship work, but early in the latter year the Edison Company installed a plant on the *Queen of the Pacific* and on Mr. James Gordon Bennett's steam yacht *Namouna*. The former plant was installed as the result of the success of the one on the *Columbia*. The next we hear is of the light being used on the Russian steamers plying

DYNAMO ROOM, STEAMER COLUMBIA.

the river Volga in the summer of 1882. There is a description of the *Queen of the Pacific* in one of the early bulletins of the Edison Company, showing 146 lamps to have been installed. The circuits were so run that any individual lamp could be controlled. Switches were placed under the direction of the steward, one switch controlling all lamps forward of the engine room, another saloon, dome, and shaft alley. The lamps were arranged to screw into a socket in the ceiling of each state room, and the wires were led in such a way as to be concealed. The last of July, 1882, it was reported that the plant on the yacht *Namouna* operated without accident on a voyage across the Atlantic.

During this summer plants were also installed on the Long Island Sound Norwich Line steamer *City of Worcester*, and on the steamer *Carolina*, of the Baltimore Bay Line. Later in the fall a plant was ordered for the steamer *Virginia*, of the latter line, and for the *Albatross*, of the United States Fish Commission. Of 22,000 lights installed up to October, 1882, 2,000 of them had been placed on steamships.

In December, 1882, an order was given for a plant of 120 lights for the steamer *Kate Adams*, running on the Mississippi river. About the same time the English Edison Company received an order for plants for two ocean steamships for the Ocean Steamship Company of New Zealand. The first one, the *Tarawera*, was thrown open to the public in December, 1882. This was the first



EDISON BIPOLAR DYNAMO, CAPACITY 60 10-C. P. LAMPS, INSTALLED ON S. S. COLUMBIA IN 1880.

English vessel on which the Edison system had been applied. There were 150 lamps with an L type of machine, driven by three-cylinder Brotherhood engine. The captain stated that the electric plant on this vessel worked well throughout the voyage from Greenock, Scotland, to Melbourne, Australia.

Early in 1883 a plant was ordered for the steamer *Carolina*, of the Oceanic Steamship Company of San Francisco, running between San Francisco and the Sandwich Islands. In a report of the collision between this steamer and the *Riverdale*, the captain of the *Carolina* said (January, 1883): "We had a most satisfactory demonstration of the working of the Edison electric lights, which were only extinguished in the damaged part of the boat, thus removing all cause of fire, which would have been certain had any other method of lighting been employed."

The description of the plant on the steamer *Pilgrim*

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in April, 1883, shows that there were 910 lamps installed, the current for operating being generated by one L and two K dynamos, driven by two Armington and Simms engines belted direct to the dynamos. Steam was furnished from a special boiler at 80 pounds pressure. Connections were also made with the ship's donkey and main boiler, to be used in cases of emergency. The dynamos were arranged to be used together or separately, and regulated by an Edison regulator. Current was taken from the dynamo room to the main deck through Edison tubes; these ran vertically on the forward side and there divided to each side of the boat. Each branch ran aft to the center of the boat and from there was run vertically to the ceiling of the galley deck. It was the intention to provide a system that would prevent the lamps being extinguished by an accident, each section being independent of the other.

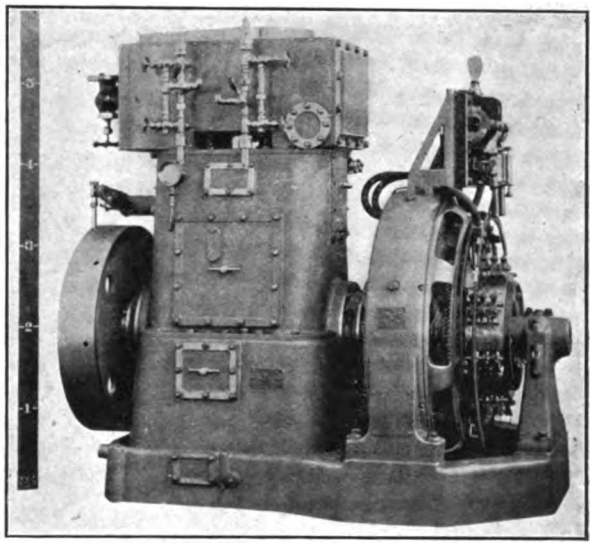
In June, 1883, the London Edison Company installed a plant on the steamship *Oregon,* which was building at Glasgow for service between Liverpool and New York; and on the steamer *Rio Pardo,* for the Brazilian coasting trade. In the bulletin of May 31, 1883, the Edison Company reported twenty-four plants on steamships, aggregating 4,850 lights. The first steamship of the United States Navy to be electrically lighted was the *Trenton;* in August, 1883, 150 lights were installed.

In part, a report of the chief engineer of the *Albatross* is as follows: "There are 139 8-c.p. lamps placed in multiple arc and so distributed throughout the vessel as to illuminate every place where light is desired. There are four circuits, viz., a double circuit on each side of the ship for the forward lamps; a double circuit on each side of the ship for the after lamps; a single independent circuit for the outside lamps, with switch in the engine room; and an independent circuit for the engine room. The mains are not only double circuits, but each consists of two No. 10 wires. The advantage of this system of wiring is manifest, as, in the event of breaking a wire from collision or other cause, the remaining wires will be ample to carry the current. The mains, however, are brought together and soldered where they are attached to the binding posts of the dynamo.

"The wires are insulated with cotton cloth and white lead, and when passing through damp places they are further protected by rubber tubing. On each main wire and near the dynamo, as well as near each group of lamps, is a cut-out plug which contains a short piece of fusible wire. The main office of this plug is twofold: it may be used as a switch to cut that wire out of the circuit at pleasure, also to prevent the heating of the wires beyond the fusing point of the metal (400 degrees), thus rendering the system harmless as to fire."

In this same report Chief Engineer Baird made very elaborate tests to determine the cost of operating, and gives a comparison of the cost of the electric light with gas on the basis of price charged by the Washington company. He figured out that the cost of the gas would be a little over three times what the Edison incandescent lamp was costing on that ship. He omitted the cost of labor, as no additional men were required for running the dynamo and engine. He figured out the electric light as costing $0.0135 per candle power per hour.

In the first installations simply a paraffin-covered copper wire was used for carrying the current; now there is first a layer of pure para rubber, then vulcanized rubber with a large quantity of the best grade of rubber in the compound, then braid, and either lead or steel tube for the outer covering. When the character of the work at that time is compared with that of the present day, one cannot help being impressed with the durability of electric plants. If, with such means as they had at their command in the early days, successful installation could be made, how much greater should be the results obtained at this time! Any well-designed installation today should last as long as the hull of the ship. The liability to damage from fire is a minimum. There is freedom from dirty, ill-smelling lamps which render ventilation difficult, and there is practically no heat. Electric fixtures are easily adapted to ornamental designs



MARINE GENERATING SET, CROSS COMPOUND ENGINE, GENERAL ELECTRIC TYPE.

and the lamps can be arranged to give the best lighting effect, and, for power purposes, a matter of no small account is the freedom from leaky steam pipes through cargo spaces.

GENERAL CONSIDERATIONS FOR MODERN PLANTS.

THE ENGINE.

In planning for the electric plant to be installed on board ship, consideration of the purposes for which the current is to be used must be given, whether to be used for lighting alone or also for driving auxiliaries. In this series of articles it is intended to treat of the uses for lighting and power, whereas the subject of indicators, telegraph, etc., is a specialty and need not be considered in connection with the other installation.

It may be stated generally that direct-connected generating sets should be installed for all classes of work; these consist of an engine and electric generator connected by shaft or coupling and mounted on a single cast-iron base. They vary in size from 2 to 100 kilowatts; the engines single or double tandem and compound, and generators compound wound from 60 to 125 volts.

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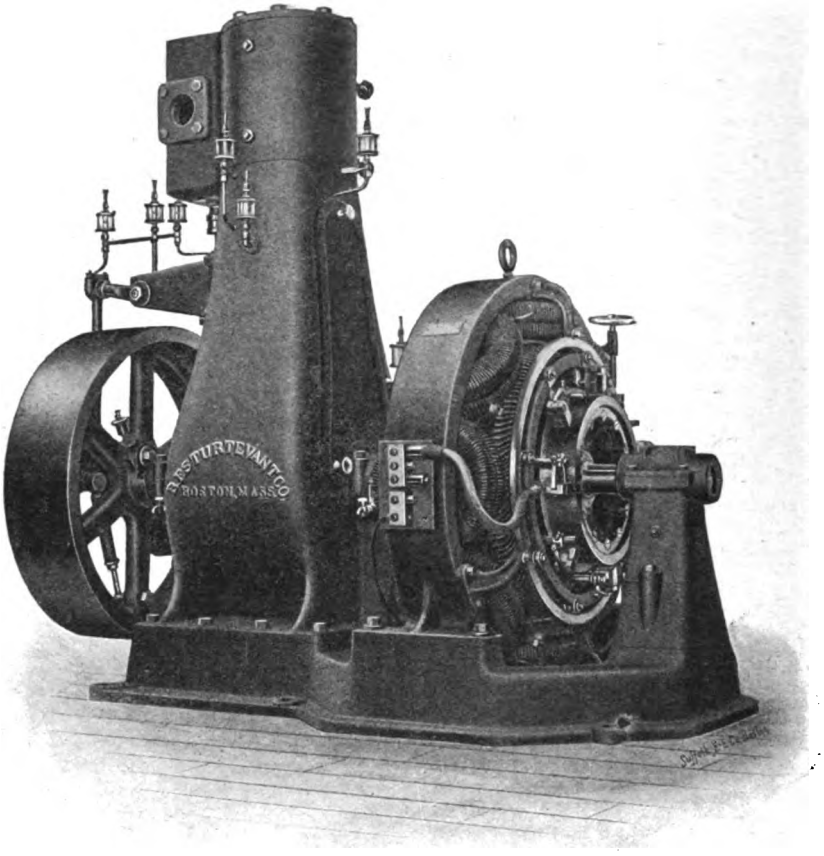
In the original installations the machines were all belt-driven, as they were designed for very high speed, but later, when it was possible to design machines with lower speed, the United States Navy introduced direct-connected sets and used them exclusively. The change has gradually come about, and now it is the exception when a belt-driven set is installed on a steamship. The conditions in the engine room of the steamer, where the plants are usually installed, render the use of a belt very objectionable. The space required for the belted plant is greater than the direct-connected, which was also a large factor in bringing about the change, as, in designing machinery for use on shipboard, weight and space are questions of vital importance.

The reciprocating engines as used at the present time for small plants are generally vertical, single-cylinder, double-acting. A few years ago it was believed that the double-cylinder engine was the only practical one for driving electric machines. These engines were designed with short stroke, very high speed, and were made very light. They were so wasteful in the use of steam and deteriorated so rapidly that longer strokes were used in later designs and the machines made heavier. Under these conditions it was possible to design a single-cylinder engine that gave very good economy, and, on account of the simplicity of construction, had good wearing qualities, was well balanced, and could be depended upon to operate under all conditions met with on shipboard. For the larger sets and for use with higher steam pressures the single-cylinder set is modified into a tandem compound, which has the same advantages of simplicity in the moving parts. As head room is often limited, the cross compound engine is used to a large extent, and there are many well-designed, substantial engines of this type in use at the present day.



SINGLE-CYLINDER, DIRECT-CONNECTED STURTEVANT TYPE OF MARINE GENERATING SET.

SIZE AND NUMBER OF UNITS.

If, as is generally the case, the current generated is for lighting principally, where the plant has to run for several hours under practically constant load and the balance of the time at a gradually varying load, a compound engine can be installed for the purpose of economy; but generally it will be found, unless the plant is a very large one, of 500 or more lights, there will be very little gain in the use of compound engines. It is generally feasible to run the plant condensing at the time of heaviest load, and if the main condensers are not operating it is usually when the vessel is in port and the full complement of light is seldom used. At light loads the economy of the compound engine over the simple engine is not marked. If, in addition to the lighting load, there is a power load that is varying greatly, the compound engine would not be operating economically. Therefore, for all plants under 50

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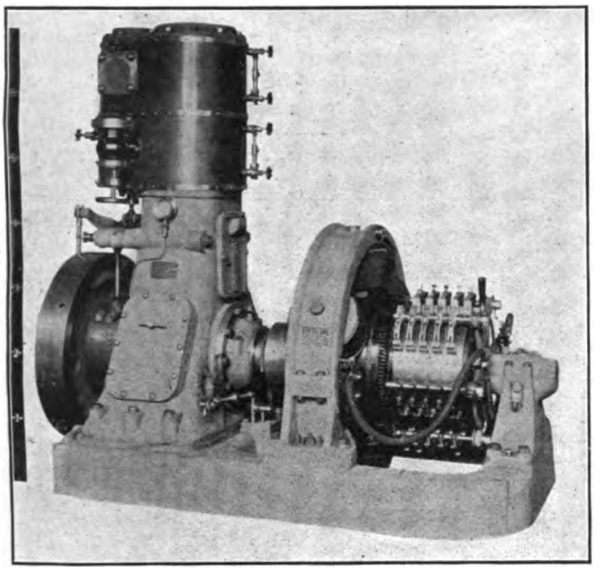
kilowatts, it should be satisfactory to install single-cylinder engines. It is preferable to install two or more generating sets where the load varies, either set to be a little larger than necessary to carry half of the load.

When the full load is on, two sets could be running without being overloaded, and in case of emergency one set could operate at an overload and take care of all the necessary lighting. For periods of light load, one set could be in operation under conditions of half-load, thus giving fair economy. For all plants with 200 lights or less, one direct-connected, single-cylinder set will be found to be generally satisfactory and reliable under all conditions of service.

In planning a large plant for the use of lighting and



STANDARD SINGLE-CYLINDER MARINE GENERATING SET. GENERAL ELECTRIC COMPANY.

power, sufficient capacity should be supplied for taking care of all of the lights and all of the ventilation, with the sets operating practically at normal load.

This will generally be sufficient to take care of the hoisting apparatus, which is in operation at times when the lighting and ventilation load is light. It is not desirable to install a plant that is much too large for the work to be done, for the conditions on shipboard hold much the same as on shore. In a central station plant for large power purposes the generating capacity is never sufficient to care for the total load in case all the motors are operating fully loaded at one time, as it is found unnecessary to install a plant for more than ½ to ¾ full-load requirements. The plant should be located conveniently with reference to the main steam supply, and where it will be well cared for and can be properly installed so as to be free from vibrations or noise that may be transmitted to various parts of the ship.

In locating the generating set on shipboard it should be placed with its shaft fore and aft. If placed athwartships the rolling of the ship may interfere with the lubrication of the bearings and cause trouble. The deck on which the set is placed should be stiff, and it is well to put stanchions between the decks beneath the bed plate. The cast-iron bed of the generating set should rest on a framework of wood, from 3 to 4 inches thick, which is well fitted to the deck. The generating set should be secured by foundation bolts which connect with the deck beams, if possible. The wooden base should be covered with a sheathing of lead slightly raised around the edges outside of the base, to act as a trough to collect oil and water which accumulate around any steam engine. In connecting up the engine, sharp bends in the steam and exhaust pipes should be avoided as much as possible. All pipes should be well covered with non-conducting material. A drain pipe with valves should be provided just above the throttle valve, in order to drain the pipe line of condensed water. A separator should be installed on the steam pipe close to the engine, to collect water which is occasionally carried over in the steam. The engines are generally fitted with a relief valve, but these are not intended to take care of any flood of water. Where the single-cylinder simple engines are used the most economical pressure at which to operate is from 80 to 100 pounds. As most vessels to-day are designed to carry a much higher pressure than this, it is necessary to install a reducing valve in the steam pipes leading to the generating set. This should be located in or near the dynamo room.

The high-pressure valve in most generating sets is of the balanced-piston type. The use of this type of valve secures a light mechanism with freedom from friction, which is easily controlled by the governor, thus insuring good regulation. There is a difference of opinion as to the type of valve best suited for the low-pressure cylinder on compound engines. Under most conditions of service it has been demonstrated that the piston will operate with much satisfaction. The balanced slide valve, if properly designed and accurately fitted, will probably give less trouble from leakage of steam. In case of any unusual pressure in the low-pressure cylinder it will lift from its seat and free the cylinder. Piston valves for both high- and low-pressure cylinders have given excellent results, however, and are recommended for all types of engines intended for electric service.

In the engines built in this country, shaft governors are used exclusively, and generally these are of the inertia type, controlling the valves by means of an eccentric pin on the flywheel, the centrifugal force of which is opposed by a spring. Any change of load will tend to change the speed, thus moving the weight, which draws the eccentric pin to or from the center of the shaft, changing the throw of the valve and varying the steam admission so as to maintain the engine at practically constant speed. Governors are usually designed to change the cut-off from ¾ to zero.

LUBRICATION.

Generally the lubrication of the engine is obtained by a conveniently located oil tank with a number of adjustable sight-feed tubes. There has been a tendency recently to use what is known as the forced system of lubrication. In this there is a pump connected with a reservoir, which is operated by an eccentric on the engine shaft, forcing the oil to grooves in the main bearings, from there to the crank pin, thence to the wrist

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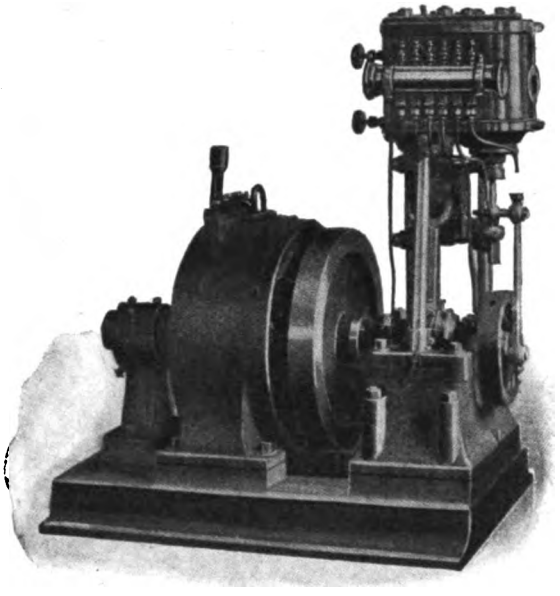
pins and guides. It is then returned to the base, strained, and forced again through the bearings. A constant pressure of oil on all the main bearings of from five to twenty pounds is maintained. This system has been found to be perfectly reliable, preventing hot bearings and reducing wear to the minimum with the least attention.

Only mineral oil should be used, and better results are had with heavy oils. A mixture which has given good results is 2-3 heavy engine oil and 1-3 heavy cylinder oil. All lubricants will gradually become thick and gritty after having passed through the bearings repeatedly, so occasionally the oil should be drawn off, filtered, and mixed with new oil.



FORBES HIGH-SPEED, LIGHT-WEIGHT ENGINE AND DIRECT-CONNECTED GENERATOR.

As regards cylinder lubrication there is much difference of opinion; it is generally claimed that boilers are damaged by the introduction of oil, and it is the endeavor of all engineers now to operate without oil in the steam spaces. There is no doubt that a cylinder can be run without the use of a lubricant, if care at first is exercised in securing a perfect surface; but when the engine is shut down the cylinders will rust, and on starting up again there must of necessity be considerable wear and cutting due to grit which is cut off by the piston.

It is recommended that instead of doing away entirely with the cylinder lubricator, one should always be installed, and while the engine is in operation very little oil be used, but before shutting down the oil feed should be increased and the working surface well covered with a film of oil. One of the advantages of the steam turbine is the doing away with all lubrication in the steam spaces.

Piston rods should be of forged steel, also connecting rods and crank shaft; the main bearing boxes should be babbited cast-iron shells firmly secured in the bed of the engine; this construction facilitates adjustment and repairs.

GENERATORS.

The electric generators for use on shipboard have developed along the same lines as for those for use on shore. The universal practice to-day is to use armatures with the slots punched in the laminations, which are assembled on shafts forming the main body of the armature, the conductors embedded in these slots and ventilated by means of air ducts formed in the armature body by space blocks placed at intervals between the punchings. The armature coils are all form-wound, thus securing uniformity of construction, and when assembled on the bodies and connected to the commutators insure a good mechanical job.

The commutator, brushes, and brush holders should be kept perfectly clean and free from dust. The commutator should be wiped occasionally with a piece of canvas slightly coated with vaseline or oil, but lubricant of any kind on the commutator should be used sparingly.

(To be continued.)

Special Session of the Board of Supervising Inspectors of Steam Vessels.

Under date of May 23, Leslie M. Shaw, Secretary Treasury Department, issued the following circular to those interested in the revision of the laws, rules, and regulations of the Steamboat Inspection Service:

"The Department, being in receipt of numerous letters from the large marine-boiler manufacturing companies throughout the United States, and many other marine associations, as well as individuals interested in the marine laws, and rules and regulations of the Steamboat Inspection Service, calling for a revision of many of the rules and regulations governing the construction of marine boilers, and relating to the inspection of vessels and licensing of officers, also the inadequacy of the present laws to meet the requirements of the growing marine interests of the country, has deemed it advisable to call an extra session of the Board of Supervising Inspectors of Steam Vessels, to meet in the city of Washington, D. C., on Wednesday, June 3, 1903, for the purpose of joint consultation relative to revising the said rules and regulations, and to consider and recommend to Congress at its next session such revision of the laws as may be necessary to meet and carry out in the most effective manner the intent and purpose of the provisions of Title LII relating to the Steamboat Inspection Service.

"With a view to obtaining all the information possible, and to meet the wants of all concerned, the Department extends to all interested an invitation to suggest to the Board of Supervising Inspectors at this extra session, either in person or by written communication, such changes as they may deem of a character worthy of consideration."

It will be remembered that during the close of the last session of Congress a bill was introduced for the appointment of a special commission to investigate what changes ought to be made in the present rules and to recommend same to the next Congress. The bill did not pass. The Secretary of the Treasury has decided that special legislation was not necessary and that such investigations may be carried on through the Supervising Inspectors. Change of rules is only possible by act of Congress, while the regulations may be revised by the action of the Board of Supervising Inspectors.

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The Board, under the presidency of Mr. George Uhler, Supervising Inspector General, is hearing most interesting and voluminous communications from shipbuilders and boilermakers throughout the country, with the intention of thrashing out the rules for recommending almost an entirely new code to the next Congress.

SHAMROCK III.

Voyage of the New Challenger.

Convoyed by the steam yacht *Erin* and the big Liverpool tug *Cruiser*, Sir Thomas Lipton's defeated challenger *Shamrock I.* and the untried challenger *Shamrock III.* arrived in the New York harbor on June 14, after a rough voyage of 16 days and 22 hours from Gourock, Scotland. This time included one day's stop at Fayal, in the Azores, to replenish the coal supply of the steam consorts. An average speed of about 240 miles a day was attained throughout the voyage of 3,644 miles. The yacht *Erin* is equipped with the wireless telegraph and dispatched several messages to the shore, reporting rough weather most of the voyage. On the second day out, and three days before arrival, easterly gales were encountered, which, however, did no damage to the little fleet. The *Shamrock III.* will be in charge of Capt. Bob Wringe in sailing the cup races. Mr. Fife, the designer, has sailed for this country in company with Sir Thomas, and, upon their arrival, the trial races between the three *Shamrocks*—for it will be remembered the *Shamrock II.* was left at Erie Basin—will be commenced.

The *Shamrocks*, in cruising rig, were manned by 42 men each, and the entire fleet of four vessels was 160. The *Erin* and *Shamrock I.* are already well known in these waters, and particular attention is attracted toward the new challenger, while her consort, the *Cruiser*, also was the subject of much interest, as she is a type of vessel unknown to these harbors. It would appear that the new challenger much resembles the *Columbia* above water. Herewith is presented a view of the *Shamrock III.*, taken before she left the other side, and in racing trim.

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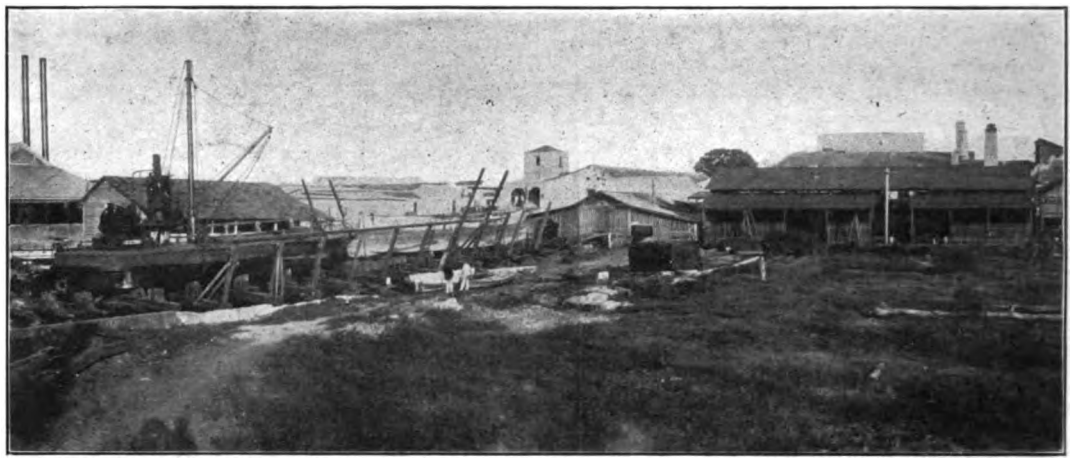

BIRD'S-EYE VIEW OF THE KRAJEWSKI-PESANT

KRAJEWSKI-PESANT COMPANY.

After the war with Spain, in 1898, the Krajewski-Pesant Company, of New York, acquired a large tract of land on the water front of the harbor of Havana, Cuba, at Regla, where a machine shop and foundry had been established several years previously. Up to this time the company had not entered the marine field, but for many years had been a manufacturer of sugar machinery. At the new plant at Regla a boiler shop was built and equipped with modern tools, and the foundry and machine shops were enlarged and improved by the acquisition of new tools and machines.

The shipyard is known under the name of the Havana Iron Works, and has a frontage of 435 feet and a depth of water of 22 feet at low tide. There has recently been built a wooden pier 325 feet long and 30 feet wide, and it is the intention of the company to build two more piers.

In 1901 a large floating dry-dock was built by the company, which, as shown in the engraving, is placed close to the shops. The capacity of this dock is for vessels up to 6,000 tons. It is of the composite type—namely, made of steel frames, planked with heavy timber pine, covered with tar, felt, and copper sheathed. The total length at the keel track is 360 feet, the width between the side walls or wings is 70 feet, and the extreme width over all is 88 feet. The dock is equipped throughout with modern improved machinery and for working at night-time is lighted with electricity.

Besides this dock, the company has also in operation a marine railway of 400 tons capacity, for handling the smaller class of work. There are facilities for conducting all kinds of marine repairs at these works, and also for building steam launches, barges, marine boilers and engines. It is anticipated that the capacity of the yard will be increased by the building of new shops and erection of improved tools and machinery in the near future.

Canadian-Built Dredge.—We are requested to state that the dredge *J. Israel Tarte,* described in the June number of MARINE ENGINEERING, was designed for the Department of Public Works, Canada, by Mr. A. W. Robinson, consulting engineer.

FORTY-SEVENTH MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

From June 23 to 26 the forty-seventh meeting of the American Society of Mechanical Engineers was held at the United States Hotel, Saratoga, N. Y. An interesting number of technical papers were read, a synopsis of which will be found below. A local committee provided entertainment for the guests in the form of receptions and excursions to several large manufacturing companies in that district. Included in the latter were trips made to the works of the General Electric Company and the American Locomotive Works at Schenectady, and to several points of interest in the immediate neighborhood of Saratoga.

Abstracts of the papers read at this meeting are as follows:

TESTS OF 12-HORSE-POWER GAS ENGINE TO DETERMINE THE EFFECTS OF CHANGES IN SPEED, LOAD, POINT OF IGNITION, RATIO OF GAS TO AIR, AND JACKET TEMPERATURE; BY PROF. C. H. ROBERTSON.

This paper gives the record of tests made at Purdue University and continuing over a period of six years. The equipment of the engine with indicator rig, Prony brake, gas meter, etc., is shown and described. The tests were 15 minutes in length in all cases, and the conditions under which each series was run are given. It is stated that not until the fourth year were most satisfactory results reached. The curves of results show—1. At a given notch of the mixer valve, speed, jacket temperature, and point of ignition, that the ratio of gas to air decreases as the horse power is increased. 2. The effect of a given change in the position of mixing valve, upon the ratio of gas to air, is very much more marked at the lower than at the higher notches. Also, that a change in the position of the mixing valve, or in the setting of the gas valve, is accompanied by a change in mechanical efficiency. The author's conclusions are stated under subheads, First, in regard to the effect of changes in point of ignition. (*a*) The highest mean effective pressure is secured between normal and late ignition, probably close to the former. (*b*) An increase of horse power calls for a later point of ignition if the highest and mean effective pressure is to be secured. (*c*) Early ignition causes an increase in frictional horse power.

Concerning changes in jacket temperature—(*a*) Increase in jacket temperature produces decrease in mean effective pressure, and the effect is more marked at low than at high powers. (*b*) Increased jacket temperature produces decrease in frictional horse power. (*c*) Increase in jacket temperature produces decrease in heat absorbed by jacket. Concerning the effect of change in speed—(*a*) Increase in speed produces increase in mean effective pressure. (*b*) Increase in speed produces increase of frictional horse power. (*c*) Increase in speed necessitates increased gas consumption per horse power.

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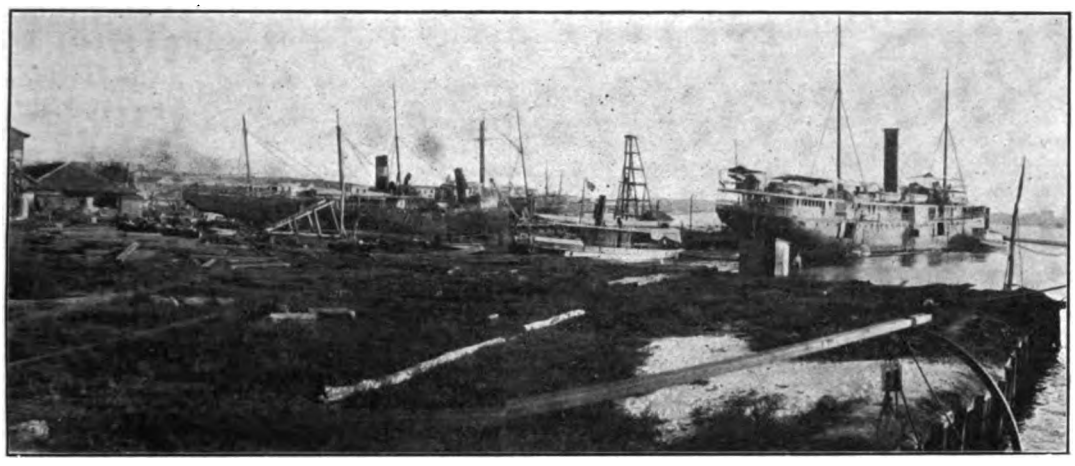

COMPANY'S WORKS, AT REGLA, HAVANA, CUBA.

Concerning the effective changes in brake horse power—(*a*) Increase in horse power causes a decrease of mean effective pressure, the increased power being secured by an increase in the number of explosions. (*b*) Increase in horse power increases the frictional loss up to three H. P., above which a decrease is shown. It is suggested that this decrease at the higher powers is due to decrease in piston friction—due, first, to the increased time of contact with heating gases; second, to the decreased contact with cold air; third, to a higher temperature of the cylinder lubricant, thus minimizing the transfer of heat to the jacket water.

Conclusions in general. (*a*) The lowest gas consumption per indicated horse power and the highest thermal efficiency are secured under the following conditions: Ignition between normal and late jacket temperature, lowest used, or 90 degrees: speed, lowest tried, 150 R. P. M.; brake horse power about six-tenths of normal capacity of the engine. (*b*) From the practical standpoint of gas economy and thermal efficiency based upon brake horse power, the frictional horse power is an exceedingly important factor, being, in many cases, sufficient to more than counterbalance the decided thermal disadvantages. The lowest fractional horse power and the highest mechanical efficiency are secured with late ignition, high jacket temperature, low speed, and the highest horse power available.

BURSTING OF EMERY WHEELS; BY C. H. BENJAMIN.

This paper with illustrations and table gives the results of tests made on a number of emery wheels of various makes, bought in the open market. The wheels selected were all of one size and were tested to the bursting speed by the same method as used in "The Bursting of Small Cast-Iron Flywheels," as described in Vol. XXIII. of the Transactions. The illustrations show the character of fractures, and the table includes the working and bursting speeds and factors of safety.

UNITED STATES ARMY GUN FACTORY, WATERVLIET ARSENAL, NEW YORK; BY J. M. B. SCHEELE.

The object of this paper is to give a general description of the Watervliet Arsenal for the benefit of those members who avail themselves of the invitation to visit the arsenal. A brief account of the shops is given, and attention is called to the most interesting details.

THE HOT WELL AS AN OIL EXTRACTOR; BY A. H. ELDREDGE.

The author gives a brief description of the details and action of the hot well and its use for the separation of oil from the water from the cylinder which passes through it. (Illustrated.)

TESTS OF AN HYDRAULIC ELEVATOR SYSTEM; BY REGINALD PELHAM BOLTON.

The system detailed in this paper is that installed in a new department store in New York. A description of the various elements is given, and the general conditions which prevailed during the trial. Types of elevators, pumps, engines, and boilers, etc., are all given, and sample indicator cards are shown. The results of the observations are recorded in the customary manner.

FITS AND FITTING; BY STANLEY H. MOORE.

The author makes an investigation of recent practice in forcing, shrinking, driving, and running fits, and limits for limit gages. The crude or working material upon which the investigation is made was obtained from the published data in various technical papers, including the results of scientific investigation and successful practice. The method of obtaining the resultant formulæ is explained and the subject taken up under the various headings given above. For each case the data are transferred to rectangular co-ordinates where the curve is plotted for the purpose of obtaining a probable law. An empirical formula is next deduced and transferred to a so-called typical diagram. Representative curves are next selected which would clearly indicate good practice. A diagram showing the curves is given for each individual case, and also one of the representative curves for the various fits. The results are also included in a table at the end of the article, as a convenient form for reference.

POSITIVE GOVERNOR DRIVES FOR CORLISS ENGINES; BY A. H. ELDREDGE.

The author strongly advocates the use of gearing or sprocket and chain to replace belts for governor drive. He cites a case of three compound engines driving alternating-current generators. With belt drives it was impossible to keep oil from the belts, and great difficulty was experienced in throwing any two of the alternators in parallel, as the engine regulation was so poor. A positive bevel gear drive was then installed, since which time the alternators can be run in parallel with greatest ease. The sprocket-and-chain method is applied to a cross-compound Ball ice machine, and has given excellent satisfaction. Chain drive is cheaper than the geared drive, and is not affected by wear of the main bearings, requires less attention, and runs much more quietly. The appearance, however, is not so good. With the belt drive there is always the danger of slipping and a runaway engine where the so-called safety devices fail to work. (Illustrated.)

TURBINE FLOW RECORDER; BY C. M. ALLEN.

The author outlines the usual method of measuring the amount of water used when bought from an outside source of supply. He then explains the design and action of a device which automatically records the quantity of water discharged from a turbine with variable gate openings and under variable heads. The single- and double-cylinder types of recorder are then described, and the method of attachment. A further modification of the machine enables it to record the flow of water in mill-power hours. This paper was presented at the January meeting in New York city. (Illustrated.)

SHOP MANAGEMENT; BY FRED W. TAYLOR.

This paper is a very exhaustive treatise on some of the different systems of shop management, including methods of timing the rate of work, the amount of the day's work, and the methods of rewarding the laborers.

THE MECHANICS OF AIR-BRAKE SYSTEMS; BY H. G. MANNING.

As a preliminary, a short historical account is given of the

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present air-brake system, and the three companies are mentioned whose systems are now in use. The general principles follow, and attention called to the fact that these systems differ only in small mechanical details. After mentioning the essential elements, the different types of air pumps are taken up, then follows a description of the engineers' valve, with the details in which the three types differ. The service and emergency application of the brake are discussed, and the paper closes with a description of the three types of triple valve.

THE STEAM TURBINE FROM AN OPERATING STANDPOINT; BY F. A. WALDRON.

This paper treats the subject not only from an operating standpoint, but includes as well data from the boiler room to the motor pulley. There is first given a general statement of facts which led to the choice of a Westinghouse-Parsons turbo-generator for installation in the Yale and Towne plant, continuous operation of the old plant during the installation of the new, floor space and economy being the three most important considerations. Details of the plant with methods of distribution are next given, and is followed by a brief description of the condenser plant. The motors, which are of Westinghouse and General Electric type, ranging in size from one-half to 40 H. P., and of the induction type, are discussed. Driving of tools is done by the group method, and a number of diagrams of various tests show the arrangement of shafting and pulleys. The steam end of the turbo-generating set has required practically no attention during the past year, and there has been no apparent wear of the parts. It has the advantage that it requires only a short time to warm up before starting, and the oiling, adjustment, and changing of speed are very simple. The blades have given no trouble, and the worst fault is the tendency to shut down at approximately full load, due to destruction of the vacuum. The only serious trouble was with the electrical end.

Answers are given to a number of questions, some of which are briefly as follows: It does fulfill the guaranteed economy. The noise is not excessive nor disagreeable. The continuity of operation is satisfactory. The exhaust can be used for heating purposes; it can be changed from condensing to non-condensing with ease, and this is done daily. The exciter should be driven by an independent engine. The cost of such a generating outfit is 10 to 15 per cent. less than an equivalent reciprocating engine. The vibration is not at all excessive. The paper closes with a number of boiler, economy, and motor tests.

AN INDICATING ANGLE METER; BY C. E. SARGENT.

The device described was designed to determine at sight the actual maximum variation in engine flywheels, particularly of the internal-combustion type, and its chief use is in running alternators in parallel. It is universal in its application, portable, easily attached, substantially built, and direct reading, the angular variation per revolution being shown by the position of a needle on a dial. A detailed description is given, and its method of attachment explained. (Illustrated.)

PERFORMANCE OF AN INTERNAL-COMBUSTION ENGINE USING KEROSENE AND GASOLINE AS FUEL; BY H. F. HALLADAY AND G. O. HODGE.

This paper is the outgrowth of a series of tests made to determine the economic performance of a standard internal-combustion engine of the Otto type, using kerosene and gasoline under similar conditions. The engine used was a standard horizontal four-cycle type, made by the Otto Gas Engine Company. The subject is treated under the following headings: The cooling jacket; the absorption brake; the carburetter for kerosene; the weighing tanks for fuel; kerosene used as a power gas; adjustments and methods of testing with kerosene fuel; the conditions of conducting experiments; the heating value of the fuel; the chemical analysis of fuels; fuel consumption; mechanical friction and efficiency; heat distribution; thermal efficiency and duty; conclusions, together with various tables.

ALTERNATING-CURRENT MOTORS FOR VARIABLE SPEED; BY W. I. SLICHTER.

The author does not claim that this type of motor can compete with the direct-current type where a continual variation of speed is desired, but shows that where an alternating-current system is desirable variable speed can be obtained with good results. He then discusses the characteristics of the polyphase-induction motor and the various methods of speed control, together with their advantages and efficiency.

A METHOD OF TESTING GAS ENGINES; BY E. C. OLIVER.

The object of this paper is to describe methods and apparatus in use in some tests on a 10-H. P. Otto gas engine, to determine the distribution of the heat supply by the fuel, and the temperature at various points in the cycle, and to submit the results of the heat tests. The data on which the results were based were as follows: Indicated horse power; brake horse power; weight of air; weight of fuel; heat rejected to exhaust; heat absorbed by jacket; total revolutions; total explosions; analysis of fuel; analysis of burned gas; engine constants; and duration of test. (Illustrated.)

TEST OF A DIRECT-CONNECTED 8-FOOT FAN AND ENGINE; BY E. S. FARWELL.

The object of the test described was to obtain reliable data which would serve as a guide in the selection of size of apparatus for a given case of heating. The question embodied three distinct problems—the air pipe; the fan; and the heater; the starting point is the volume and temperature of air required. The methods of conducting the test are outlined and the different details discussed. The results are embodied in a table, and various efficiency curves are shown.

A RATIONAL TRAIN-RESISTANCE FORMULA; BY JOHN BALCH BLOOD.

A brief history of train-resistance formulæ and their development is given, with discussion of each. The desirability of a rational rather than an empirical formula is outlined and a development of a formula advocated by the author is given, together with the causes necessitating additional terms, as, for example, increased train speed, and the necessity of having a formula which shall be accurate and not merely serviceable as a guide.

DRAWING-OFFICE EQUIPMENT; BY JOHN M'GEORGE.

The paper starts with a general discussion of drafting-room conditions; the question of light—both natural and artificial—is next considered; for the latter reflected light from the ceiling is given the preference, the ceilings being painted white, and the lamps being of the arc or Nernst type. The method of individual incandescent lamps is also mentioned. The question of the space allotted to each man is next discussed; three conditions controlling it being given, as—the convenience of the man, the necessary room to allow easy access to the supervisor, and ventilation. Various types of drafting boards with their relative advantages are allotted considerable space. Sanitary arrangements and electric blue-print facilities are mentioned. The Universal Drafting Machine and the Rapid-Sketching Device are described. Paper closes with remarks on drafting-office management. Paper includes a number of illustrations of drafting-room arrangement.

STRAINS PRODUCED BY EXCESSIVE TIGHTENING OF NUTS; BY A. BEMENT.

A brief paper calling attention to the fact that materials are frequently unduly strained during the process of assembling, by the excessive tightening of nuts. An example is given.

SOME DATA ON HOISTING HOOKS; BY JOHN L. BACON.

The author gives the results of some tests made on the strength of hooks bent out of round stock, and compares them with tests on those shaped according to Towne's Formula, and, further, gives the effect of case-hardening. The method of conducting tests is described, and the conclusions are outlined in a table. (Illustrated.)

WATER AND HEAT CONSUMPTION OF A COMPOUND ENGINE AT VARIOUS POWERS; BY D. S. JACOBUS.

The engine tested was of the Rice and Sargent horizontal cross-compound type, provided with a Corliss valve gear. It is located at the Brooklyn plant of the American Sugar Refining Company. The method of testing and the conditions are described, and the results are given in various tables and figures.

A COMPARATIVE OIL TEST; BY WILLIAM F. PARRISH, JR.

The test described was made for the purpose of showing the relative efficiency of two different grades of oil, both of which were made for the same kind of service, *i.e.*, spindle lubrication. These tests were made on a cotton-spinning frame of the ring type at the Union Cotton Manufacturing Company's mill, Fall River, Mass. Various dimensions of the spinning frame are

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given, and the various conditions of running the tests. The instruments used are enumerated and described. The conclusions are given in tables and diagrams.

EXPERIMENT BOILER OF OHIO STATE UNIVERSITY; BY E. A. HITCHCOCK.

This paper outlines the details and installation of an experimental boiler with its accessories in the power house of the Ohio State University, and gives the results of various trial running.

A GRAPHICAL DAILY BALANCE IN MANUFACTURE; BY H. L. GANTT.

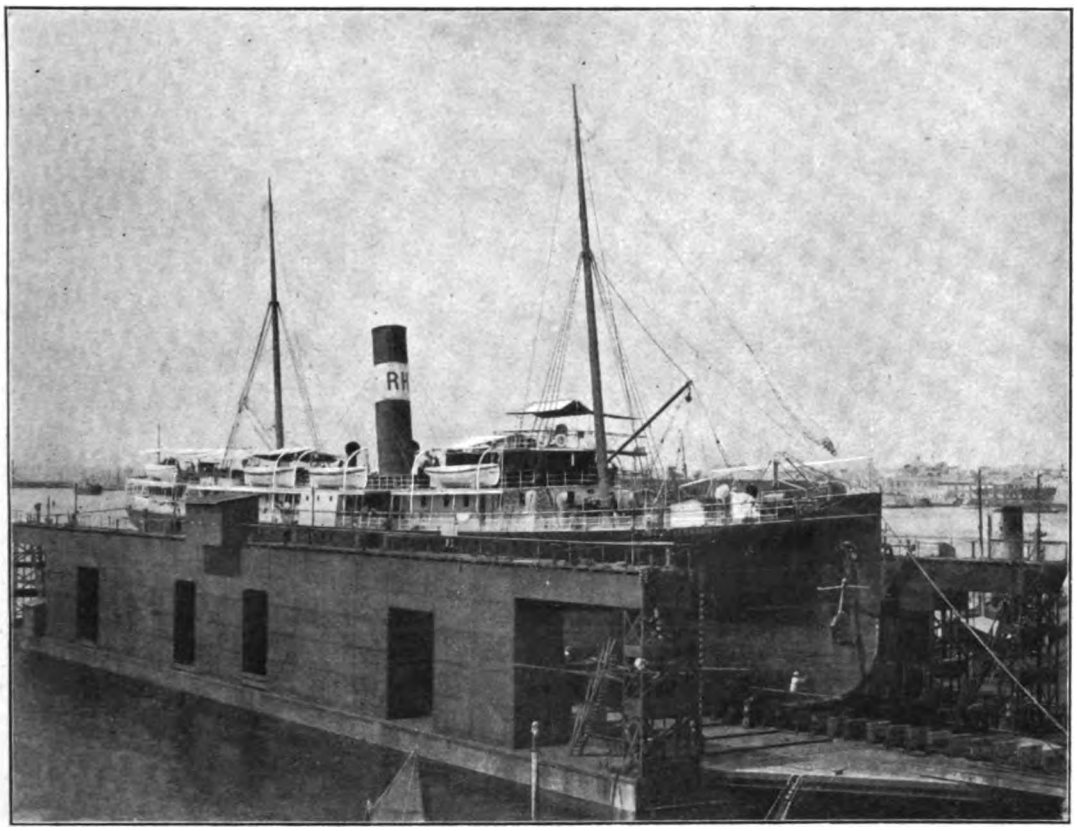
This paper may be said to be a continuation of the paper presented by the author at the last annual meeting, and calls particular attention to the method of setting the task and the method of operating the system by which an exact record was kept. The first of these two items is treated quite fully by Mr. Fred W. Taylor in his paper before the present meeting; the second item is the one which is given careful consideration in this paper. It is treated under the following headings: Man's record; daily balance of work; a foundry balance; a daily balance as a permanent record; a machine-shop balance and routing sheet; a graphical balance as a history; a value of balance not dependent upon method of compensation; the graphical balance and the foreman; cost of keeping balances; time- and production-card system; cost; progress of production; difficulty of getting a daily balance; value of such a balance. Sample forms are shown to illustrate certain points in the system.

TOPICAL DISCUSSIONS.

This includes short description of a milling-machine attachment for cutting worms. Another topic suggests the adoption of a standard form of boiler for testing the calorific value of various fuels. The third item describes a new form of flexible metallic tubing.

A 60-FOOT BORING MILL; BY JNO. A. RIDDELL.

This describes the new boring mill at the works of the General Electric Company.



FLOATING DRY-DOCK AT THE WORKS OF THE KRAJEWSKI-PESANT COMPANY, REGLA, HAVANA, CUBA.

Drawings of Modern Triple-Expansion Engines.

A thorough understanding of the triple-expansion engine and the correct names of the different parts is only clear after many months of study and experience in the drafting room and in the engine room. On the inset is presented a set of working drawings of a modern triple-expansion engine recently built, which embodies the latest designs and may be looked upon as the standard practice of to-day.

This engine is what is generally termed a vertical inverted cylinder, direct-connected, triple-expansion type, having one high-pressure cylinder 17 inches in diameter, one intermediate-pressure cylinder 27 inches in diameter, and one low-pressure cylinder 43 inches in diameter, the stroke of all pistons being 24 inches. The high-pressure cylinder, **22**, is forward, intermediate cylinder, **23**, in the middle, and low-pressure cylinder, **25**, at the after end. The valve, **34**, on the high-pressure is of the piston type, and those on the intermediate, **40**, and low-pressure, **41**, are of the slide-valve type balanced by pistons, **1**. All valves are worked by the Stephenson link motion with double bar links, **28**. Each main piston has a piston rod, **33**, and a crosshead, **12**, working in a slipper guide, **13**. At either end of the connecting rod, **5**, brasses are fitted, the upper one to the crosshead pin, **14**, and the lower one to the crank pin, **7**.

The crank shaft, **9**, in this engine is made up in two lengths, of open-hearth steel; the abutting ends have collars forged on them which are coupled together by bolts. The framing of the engine consists of three

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wrought-iron front columns, **16**, and three cast-iron columns at the back, **15**, cast in the main condenser, **3**, the condenser forming part of the framing. The engine bed plate, **2**, is also cast-iron and is laid upon a wrought-steel foundation forming part of the structure of the ship.

First let us consider the progress of steam through the cylinders. Steam enters the high-pressure valve chest through the connection marked **27**a, around the piston valve, **34**, and is admitted into the high-pressure steam cylinder, **22**, through the steam passages. As shown in the drawing, the high-pressure cylinder is on the top center; the valve is already opened to the amount of the lead to allow steam to enter behind the piston, **29**. Looking at the bottom of this piston valve, it will be seen that the lower steam passage is connected to the space below the piston valve, that is, the exhaust port is opened and steam is escaping from behind the piston to the intermediate-pressure valve chest, **47**, through the passage which surrounds the high-pressure cylinder.

Steam from the intermediate-pressure cylinder, **23**, is controlled in like manner by the slide valve, **40**; after doing its work in this cylinder it exhausts through the receiver pipe, **26**, in which an expansion joint is fitted on the line opposite the intermediate cylinder, to the low-pressure valve chest, **48**.

By means of the slide valve, **41**, it enters, performs its work, and exhausts from the low-pressure cylinder, **25**, passing into the main exhaust pipe, **27**, to the condenser, **3**, which is built in the back columns of the engine. This condenser is fitted with two nests of tubes, **4**, and through these tubes water is circulated by a centrifugal pump. The water at the bottom of the water chest, **43**, through the opening, **45**, passes forward through the lower nest of tubes, up at the forward end of the condenser, then backward through the upper nest of tubes and outward through the connection, **44**. The exhaust steam fills the spaces around these tubes, and in coming in contact with the cold surface of the tubes is condensed, falls to the bottom, and is removed by the air pump attached to the flanges at opening, **42**. This condensation creates a vacuum.

To accomplish these various operations and do it economically, each part of the engine must be studied in detail to produce the best results with the least amount of material and by using the minimum amount of steam. The reason of separate cylinders as in the multiple-expansion engine is twofold: first, the present large demands for power—one cylinder could not well be built in which to double the total amount of power, and even if so built it would not give a uniform turning moment to the shaft; and, secondly, by subdividing the expansion in two or more cylinders less condensation of steam results. This condensation is caused through the sudden heating and cooling of the cylinder walls with each revolution of the engine, due to the high temperature of entering steam and low temperature of the exhaust steam.

A REMARKABLE COLLISION BETWEEN A PILOT BOAT AND A HOUSE ON THE MASSACHUSETTS SHORE.

A Wrecked Pilotboat.

It is seldom that a vessel so far leaves her element as to come in collision with houses on the shore, but the above engraving, taken from a photograph made by Dr. F. N. Damon, Scituate, Mass., shows again that the unexpected is always liable to happen. The vessel, which is seen lying under the weather side of a house, was the pilotboat *Columbia*, blown ashore some time ago during a very heavy gale and high water. She was forced into the house, and her masts and spars falling increased the wreckage of both the ship and the home.

The view also illustrates the greater strength of the design of the naval architect than that of his land brother. The hull of the vessel was not badly damaged, but the lower portions of the house were completely wrecked and piled up, as shown.

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ON THE LINES OF FAST CRUISERS.*

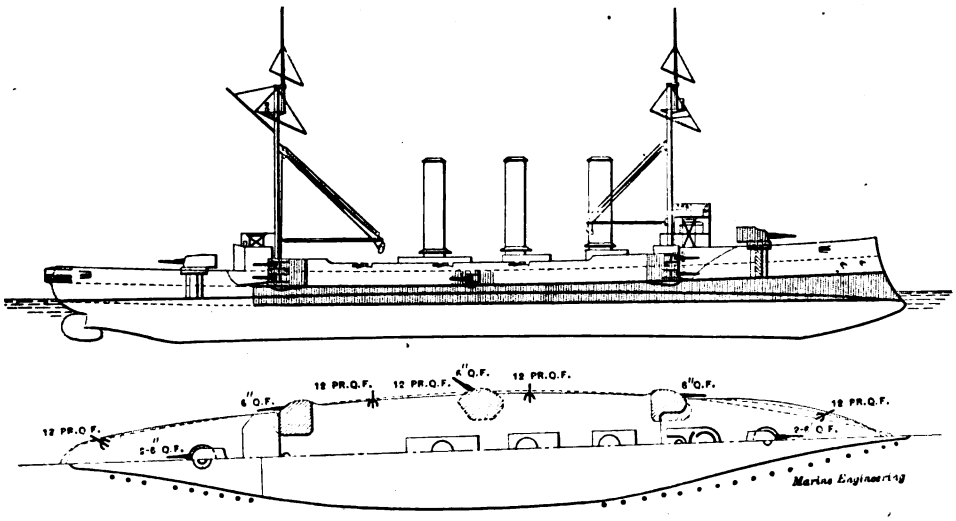
BY VICE-ADMIRAL C. C. P. FITZGERALD.

In bringing this subject before the notice of this Institution, I may say at once that I do so more as an inquirer than with the idea of laying down the law dogmatically as to what are or are not the best possible lines upon which ocean cruisers of high speed ought to be built; and, whilst venturing to offer some opinions on the subject from a seaman's point of view, I shall hope to evoke the opinions of some experienced naval architects upon the theoretical aspect of this interesting and important question, with the further hope that theory and practice may be found to go—as they ought to go—hand in hand.

Both professional naval architects and professional seamen know perfectly well that it is impossible to get high speed in any vessel without fine lines, and it is equally impossible to get very high speed without very fine lines. This sounds almost like a truism to those who know anything about the subject. No amount of horse power will avail unless the coefficient of fineness bears a certain relation to the speed required. But it appears to me that there is a great deal of difference between fine lines and hollow lines; and this brings me directly to the point which I trust some naval architects here present will elucidate for us, viz., whether there are any special advantages in hollow lines which are not apparent to the eye of a seaman, or which can be taken as an adequate compensation for the disadvantages which he knows them to possess in all conditions of wind and weather, with the sole exception of dead smooth water—a condition which, I need scarcely say, is very rare at sea.

I may perhaps point out here what I mean by reference to the Diagram on Plate I. This diagram shows the water line of our armored cruisers of the *County* class, and I think it can be scarcely open to question that their lines are very hollow, particularly the bow lines. I may observe that the ships themselves look even more hollow than the diagram shows, though this, of course, may be an optical delusion.

I have ventured to add to the original diagram a dotted line showing an imaginary water line which is not hollow, but slightly convex, and approaching more nearly to the lines of our 30-knot destroyers and of fast Atlantic liners, and I would ask the question whether these lines would require a greater horse power to drive them at a given speed than the hollow lines, even in smooth water. And, if this question is answered in the affirmative, I would still point out that by filling in this hollow, the ship would be given a greater displacement, and would in consequence be able to carry a greater weight of engines, and she would certainly be a better ship in rough water, even if there was a slight falling off in her trial-trip speed.



PLAN AND WATER LINE OF THE ARMORED CRUISER COUNTY AND CLASS.

I am quite aware that, generally speaking, comparisons between the designs of war cruisers and Atlantic liners are apt to be misleading, as the ships are intended to perform totally different services, and it is impossible to combine the requirements of both in any one ship. It is not necessary to enter into the details of this incompatibility, as they must be obvious to both naval architects and seamen; but there is one quality which is essential to both, and that is, length. You cannot drive a short ship against a head sea: it is simply impossible. Length is necessary in order to get anything like high speed in rough water; and, moreover, total length, or length over all, is of no use unless it is combined with length of floor; it is, in fact, actually detrimental, as it only increases the pitching moment. A comparatively broad and flat floor amidships, with two very fine and hollow ends, will only make a rocking machine, which may possibly be driven fast in smooth water, and may be suitable for a river steamer, but which is quite unsuitable for an ocean cruiser. I put forward these views on the subject as the crude remarks of a seaman, subject to the contradictions of applied science; but they are the result of many years' observation of the behavior of ships and

*Read at the Spring Meeting of the Forty-fourth Session of the Institution of Naval Architects, April 1, 1903.

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vessels of various classes, in all conditions of wind and weather, and they must be taken for whatever they are considered worth.

In comparing the lines of our larger ocean war cruisers with those of destroyers, it is obvious that in the latter the proportion of length to breadth is greater than in the former, thus admitting of finer lines, and this length is no doubt necessary in order to get space for boilers enough to produce the great horse power required to drive these little vessels at 30 knots; but in examining the drawings of destroyers, and in looking at the vessels themselves, I am unable to see any hollowness in their lines. The lines appear to be almost quite straight, and in some boats slightly convex, until you get aft as far as the boiler space; and yet these little vessels (putting on one side some signs of structural weakness) have proved themselves to be splendid sea boats for their size, weathering Atlantic gales and typhoons in the China seas.

TANK EXPERIMENTS.

I desire to speak with the greatest respect of tank experiments. I have not the smallest doubt that they have been of great use to naval architects in elucidating problems in hydrodynamics, and in assisting them to come to conclusions as to the form of model which offers the least resistance at various speeds. Such experiments and researches must always be useful in checking theory with practice, so far as such trials can be considered practical; though it must be borne in mind that all tank experiments relate only to smooth-water conditions, and it is quite possible that the conclusions arrived at through a combination of abstract theory and tank experiments with small models may be misleading, if applied too rigidly to full-sized ships which have to travel upon the troubled surface of the ocean. Indeed, it is impossible to help surmising that tank experiments are responsible for the hollow lines of which I am now speaking. If I am wrong in this surmise, I shall, no doubt, be corrected.

Some years ago we used to hear a good deal about the "wave line" theory; in other words, a hollow bow. Speaking from memory, I think it was introduced—or, at any rate, advocated—by the late Mr. Scott Russell: but I have certainly been of opinion that this theory has since been discredited, both by naval architects and seamen, for all ocean-going steamers, although it is possible that it may still be applied with success to river steamers; at any rate, it is certain that you will not see a hollow line in any of our fast Atlantic liners. Splendid models of these ships are on view in many public places, particularly in Cockspur street, so that any one can see for himself that there is no hollow in the bow lines; but that, on the contrary, the floor of the ship is carried right forward to the cutwater, a form which enables the vessel to rise to a sea instead of pitching deeply into it.

A COMPARISON.

It has often been urged that comparisons between British and foreign cruisers are apt to be misleading, and unfair to the former unless the full particulars are known and set forth. This, no doubt, is perfectly true; but yet, in spite of the very high authority by which this warning has been issued, I think it will not be irrelevant to the present subject to compare the British *Kent* of the *County* class with the Russian cruiser *Bayan*, built at La Seyne. The *Kent* has a nominal tonnage of 9,800, the *Bayan* 7,800, and there can be no doubt that the additional 2,000 tons ought to give a great superiority to the *Kent* either in speed, armor, armament, or coal endurance. With regard to armor, there does not appear much to choose between them, although the distribution of it is quite different; thus the *Kent* has a belt 4 inches thick amidships, tapering to 2 inches forward, carried right to the stem; and the *Bayan* has a belt 8 inches thick amidships (but very narrow and short at this thickness), tapering to 3 inches forward, and carried right to the stem. In both cases the belt stops about 100 feet from the stern. The *Kent* has a 5-inch bulkhead; but I cannot find out whether the *Bayan* has or has not a bulkhead. The width of the thin belt in both ships is about the same.

The *Bayan* is armed with two 8-inch guns, protected with 7-inch armor; eight 6-inch, protected with 3-inch armor; twenty 2.9-inch, eight of which are behind 3-inch armor; and seven 1.8-inch guns. The *Kent* carries fourteen 6-inch guns, protected by 5-inch and 4-inch armor, and thirteen 12-pounders unprotected; her armored deck is 2 3-4 inches thick, against the *Bayan's* 2 inches, and the *Kent* carries more ammunition than the *Bayan*; but the latter has two submerged torpedo tubes, and the *Kent* has none. With regard to coal supply, the *Kent* carries 800 normal and 1,600 full stowage for 22,000-H.P. engines, and the *Bayan* carries 750 normal and 1,100 full stowage for 16,500-H.P. engines.

The *Bayan* was designed for 21 knots, and made 22 on her trial. The *Kent* was designed for 23 knots, and made 21.7 on her first trial; and, although she has somewhat improved upon that, owing to some alteration in her screws, she has not yet attained her designed speed, nor have any of her sisters. Presumably the *Bayan's* trial lasted for only three hours, and the Kent's for eight. The *Bayan* is 445 feet long by 57 feet beam, and the *Kent* is 440 feet long by 66 feet beam. The 5 feet additional length, coupled with 9 feet less beam, commends itself to the mind of a seaman as being a better form than the other one for driving against a head sea; and it seems to be no worse for attaining a good trial-trip speed. I have not been able to get the lines of the *Bayan*—it is difficult to get the lines of foreign ships; but I have seen a good many French-built ships, and I can safely say that I have never been able to detect a hollow line in any of them.

In the above comparison I have endeavored to be perfectly fair, and have impartially given such information as I have been able to collect; and it certainly does not appear as if our *County* class of 9,800 tons possess such a superiority over the *Bayan* of 7,800 tons as they ought to possess. It would be interesting to know if this is in any way attributable to their hollow lines.

CONCLUSION.

It is always rash to prophesy, and yet I will venture to predict that the whole of our *County* class will prove to be very wet ships. They will be wet for two reasons: one is that their sponsons are too low, and the other is that they have hollow lines, particularly the bow lines; and this, in combination with the armor carried right forward to the stem, will make them pitch with all the venom of much shorter ships; and it must be remembered that a wet ship interferes considerably with the accuracy of gunfire.

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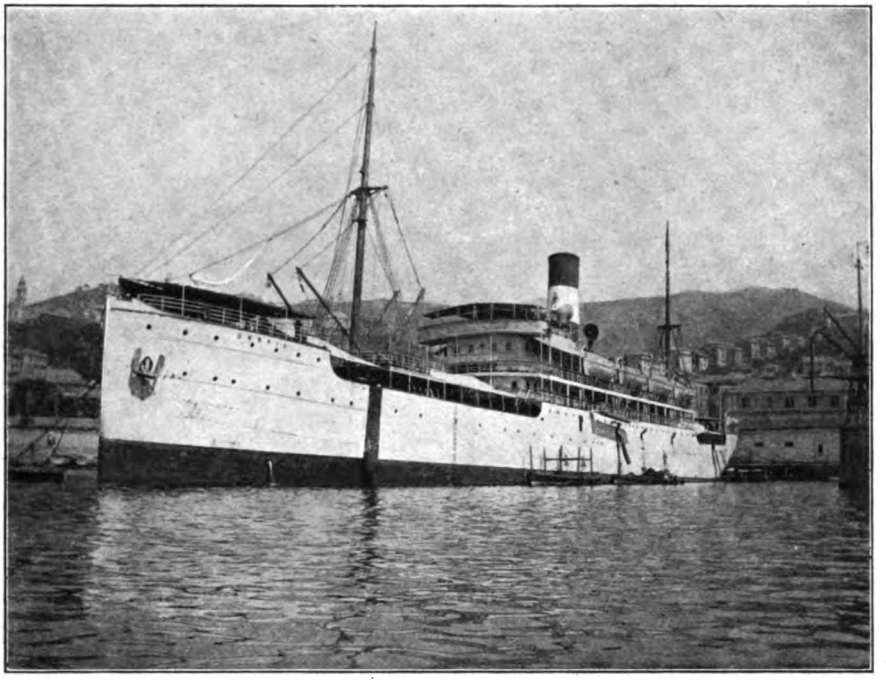
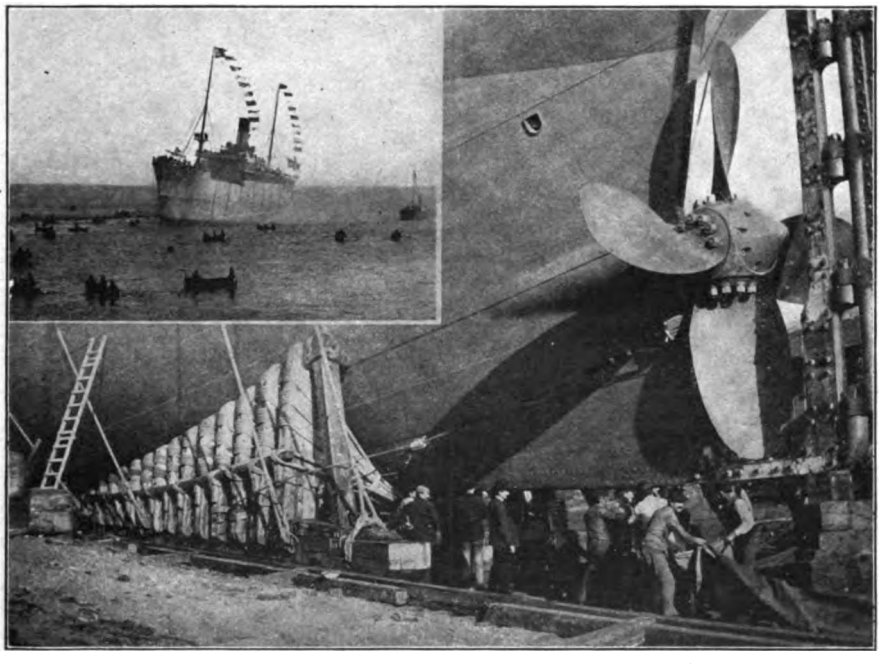
New Steamships Umbria and Liguria.

The last of the five steamers of the Navigazione Generale Italiana Company placed in the American service is named the *Umbria*. She is of the intermediate type, with large passenger accommodations and moderate speed. The other vessels recently built for this company are the *Liguria* and *Lombardia* and the *Sicilia* and *Sardegna*. The former two ships were built by Messrs. Ansaldo, and the latter two at Riva Trigoso, Genoa. All five ships have been constructed to conform to the requirements of Lloyd's and to the Italian government. The hulls are of open-hearth mild steel.



STEAMSHIP UMBRIA AT GENOA, ITALY.



LAUNCHING THE STEAMSHIP LIGURIA AT GENOA, MARCH 31.

The principal dimensions are: Length, 402 feet; beam, 46 feet 7 inches; depth to the main deck, outside, 30 feet 4 inches.

The ships have accommodations for 50 first-class, 50

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second-class, and 1,020 third-class passengers. Both classes are handsomely fitted and provision is made for carrying stores in large refrigerating chambers.

The propelling engine of the *Umbria* is of the four-cylinder, quadruple-expansion type, the order of the cylinders being, from the forward end: High, first intermediate, second intermediate, and low-pressure; while the crank sequence is high, low, first intermediate, and second intermediate, the cranks being placed 90 degrees apart. Piston valves are fitted to the high- and first intermediate-pressure cylinders, and slide valves to the other two cylinders. All are worked by Stephenson double-bar links. The valve chests of the two intermediate cylinders are placed on the backs of the cylinders, thus securing a short engine. Each cylinder and its chest is cast separately and tied together by forged steel rods at the tops and by cast-iron arms between the columns, which latter are of cast iron. The pistons are of cast steel and of weight best adapted for balancing the four cranks, the high-pressure and intermediate-pressure pistons being of the same weight and the second intermediate equal to that of the low-pressure piston. There is a separate cylindrical condenser with a steel plate shell and composition ends. The top of the condenser is arranged as a feed-water heater.

Steam is supplied by three cylindrical double-end boilers, working at 200 pounds pressure, placed in a single compartment. The auxiliary machinery, which is very complete, is in duplicate throughout to avoid the chances of a complete breakdown. On a trial trip the main engine developed a maximum power of 4,800 I. H. P., and the coal consumption during a five-hour trial was 11,097 Kg., which, figured out per horse power, was 1.13 pounds per horse power per hour; the trial was run at natural draft and the average speed throughout was about 15.5 knots. The trial was most satisfactory in all ways, and it should be remarked that these are the largest engines yet built of this type in Italy. The plans were drawn by Salvator Orlando, consulting engineer of the steamship company, and both hull and engines were built at the works of Messrs. Orlando at Livorno.

The engines of the *Liguria* and *Lombardia* are triple-expansion type, with cylinders 29 3-8, 47 5-8, and 77 5-8 inches diameter with a common stroke of 53 inches. Piston valves are fitted to the high- and intermediate-pressure cylinders, and the double-ported slide to the low-pressure, all worked by Stephenson gear; the high and intermediate have steam jackets. The cylinders are mounted on cast-iron front and back columns.

NAME—Umbria.	NATIONALITY—Italian.
LAUNCHED—1902.	BUILDER—Orlando and Co.
Length between perps	402 ft.
beam	46 " 7 ins.
Depth, molded, to main deck	30 " 4 "
Draft, trial	16 " 4 "
Corresponding displacement	6,050 tons
Wetted surf	30,560 sq. ft.
Engines: Type	quadruple expansion
Diameter cyls	27, 38 1-2, 55 3-4, and 79 ins.
Stroke	53 ins.
Valves	two piston and two slide
Rev. in service	86
Framing	cast-iron columns
Bed plate	cast-iron
Shafting, crank	15 1-4 ins.
" line	14 1-4 "
" propeller	16 1-4 "
Air pumps, direct	two
Propeller: No. of blades	four
Diameter	17 ft. 8 ins.
Pitch	18 ft. 8 ins.
Projected area	82 1-2 sq. ft.
Boilers:	three double-end Scotch
Diam	13 ft 9 3-4 ins.

TYPE—Passenger and freight steamer.	
OWNER—Navigazione Generale Italiana Co.	
Length	19 ft. 3 ins.
Pressure	200 lbs.
Furnaces	6 each
G. S. total	354 sq. ft.
H. S. "	11,820 "
H. S. + G. S	33.4
Trial Data:	
Full-power trial	4,659 I. H. P.
Speed	15.7 knots
Revolutions	90 1-2
Steam pressure	205 lbs.
Cut-offs, H. P. .685; 1st I. P. .661; 2d I. P. .674; L. P. .723	
Total expansions	12.91
I. H. P. per sq ft. G. S	13.15
Piston speed	800 ft.
Consumption 5 hour trial: Power	4,329 I. H. P.
Revolutions	88
Coal per hour	4,890 lbs.
" " I. H. P. per hour	1.13 "
" " sq ft. G. S	13.8 "

NAME—Liguria.	NATIONALITY—Italian.
LAUNCHED—1903.	BUILDER—Ansaldo and Co.
Hull	same as Umbria
Engines: Type	single screw, triple
Cylinder diams	29 3-8, 47 5-8, 77 5-8 ins.
Stroke	53 "
Valves	piston on H. P. and I. P.
Piston rods, diam	7 7-8 ins.
Tail rod on L. P., diam	5 3-8 "
Connecting rods, length	8 ft. 10 "
" " diam., mean	7 7-8 "
Crank pins, length	18 1-2 "
" " diam	15 3-4 "
Shafting, diam. crank	15 3-8 "
" " line	14 1-2 "
" " propeller	16 1-4 "
Condenser, cooling surface	5,382 sq. ft.
Tubes, number of	1,842
" size	15 ft. 2 1-4 ins. long by 3-4 in.
Auxiliary condenser, surface	430 sq. ft
Circulating centrifugal pump, 6 blades, diam	32 ins.
Air pumps, two 20 ins. diam by 23 ins.	
I. H. P. on trial	4,590
Propeller: Stone's bronze	4 blades

TYPE—Passenger and freight steamer.	
OWNER—Navigazione Generale Italiana Co.	
Pitch, variable	19 ft.
Projected area	88 sq. ft.
Developed "	104 " "
Hub, diam	51 ins.
Boilers	three double-end Scotch
Diam	13 ft. 8 ins.
Length	18 " 10 "
Pressure	190 lbs.
Furnaces, number in each	6
" smallest diam	39 3-8 ins.
" largest "	43 3-8 "
Grate surface	388 sq. ft.
Heating surface	11,408 " "
Tubes, outside diam	3 1-4 ins.
" length	7 ft. 6 "
Steam pipe, diam	10 "
Funnel, diam	10 ft. 2 "
" height	85 " 0 "
Draft	forced
Donkey boiler,	9 ft. 10 ins. diam by 10 ft. 5 ins.
H. S. + G. S	29.4
H. S. ÷ I. H. P	2.49
I. H. P + G. S	11.8

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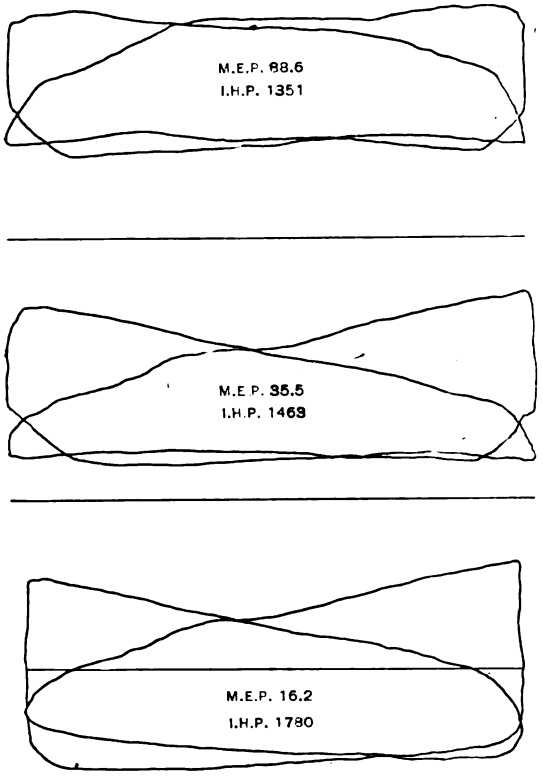
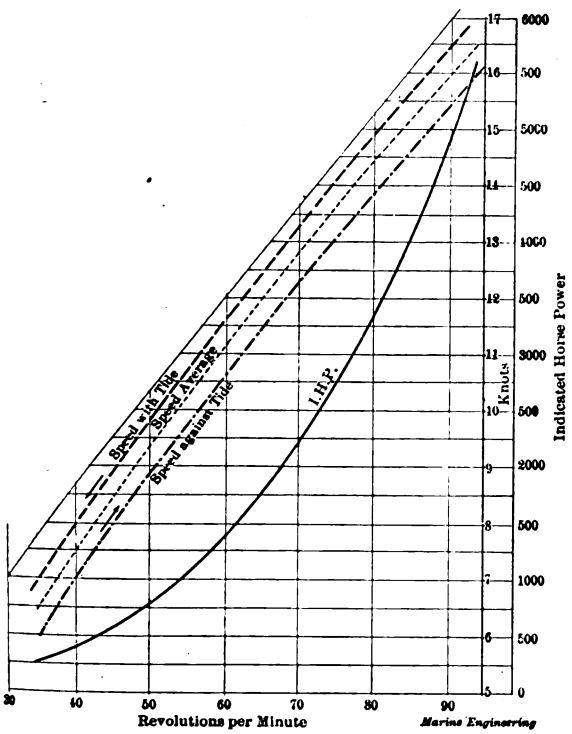


BOILERS PRESSURE	191 LBS.
RECEIVER H.P.	186 "
" M.P.	72.5 "
" L.P.	12.1 "
VACUUM	26 INCHES
REVOLUTIONS	86 "

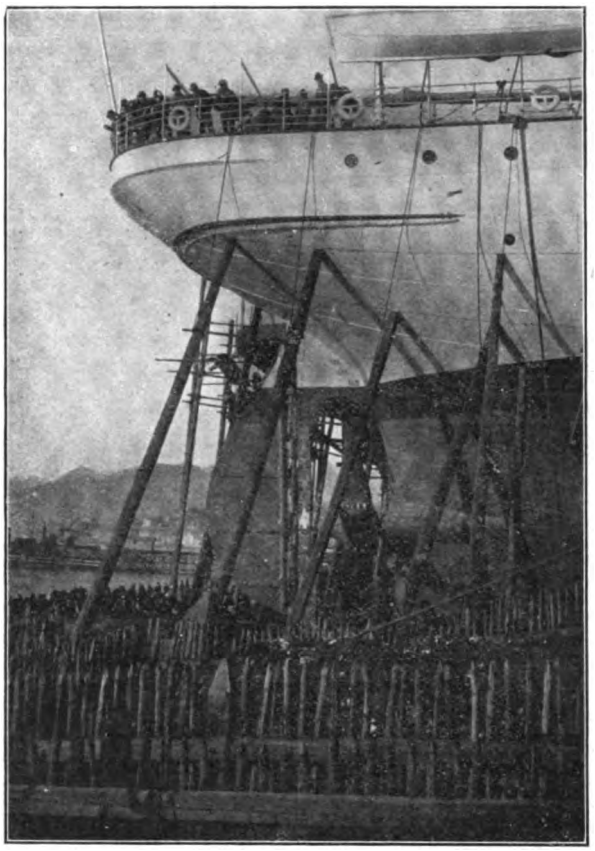
Marine Engineering

CARDS TAKEN ON THE LIGURIA.



SPEED CURVE FOR THE TRIAL OF THE LIGURIA.

those on the front being used for oil tanks; the crank shafts are Siemens-Martin, which is the material used for other moving parts, except for the propeller shaft, which is made of forged iron. Slipper guides are placed on the back columns with water circulation. The condenser is in the back framing of the engine, and two air pumps work direct from the intermediate- and low-pressure crosshead. A large evaporator is fitted for the make-up feed, and Weir feed heaters and filters are installed; also an auxiliary exhaust may be turned either into the auxiliary or main condenser or into the feed-water heater. This is true of all machinery except the



STERN VIEW OF THE STEAMER LIGURIA.

steering engine and dynamos, which have independent exhaust. Worthington pumps are installed for all other purposes, capable of handling from 100 to 150 tons per hour. Three double-end boilers supply steam at 190 pounds per square inch, each boiler being fitted with six Morison furnaces. The boilers are placed in a single forward compartment, and the uptakes lead into a funnel the top of which is 85 feet above grates and is 10 feet in diameter. Forced draft is supplied by two 66-inch fans driven by steam engines. The ships are lighted by electricity.

Lawson to be Dismantled.—The famous seven-masted schooner *Thomas W. Lawson*, launched about a year ago, it is reported, will be dismantled and converted into a barge. Her draft will not permit her to enter many of the harbors under sail, and it is reported that she is a bad ship to handle in anything but the most favorable weather.

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RUNNING EVAPORATORS.

BY EARL N. PERCY.

Nowadays almost every seagoing ship is fitted with one or more evaporators, all large ocean steamers and war vessels are equipped with them, therefore knowledge of the operation of this auxiliary is an important part of the marine engineer's education, and the efficiency depends almost altogether upon the care with which it is run. The following remarks are taken from practice and are along the lines of the writer's experience.

The usual form of evaporator is a large, cylindrical vessel for holding salt water, and designed for a pressure of about 50 pounds maximum. Within is placed a coil of pipe supplied with steam from the boilers and discharging into a trap, or sometimes into a second evaporator and then into a trap—in this case the evaporators are termed a double effect. When steam is turned into the coil the salt water is heated up to the boiling point and the vapor is led to the main condenser or filter tank for supplying the boilers or to a small condenser for drinking water. The salt in the water remains in the evaporator and is removed either by blowing out or cleaning out by hand. The evaporator is fitted with baffle plates for dividing the streams of water in the cylinder, a dry pipe for collecting the steam at the top, a water gage, blow valve, steam gage, compound vapor gage, and a salinometer for measuring the density of the water. A separate pump supplies water to the evaporator, and when a distiller is fitted it is generally supplied with a separate circulating water pump.

There are many ways in which an evaporator may be run; some engineers believe in carrying high vapor pressure and low water, while others go to the other extreme of low pressure and high water. Then, again, the feed and blow pumps are run differently, and the evaporator may be piped up in a variety of ways.

When the vapor from the salt water is led to the distiller, all the heat from it is lost and thrown away with the circulating water of the distiller, therefore the evaporator should be run at as low a pressure as is possible. If run at about 26 inches vacuum the boiling point is 124.5 degrees Fahrenheit when total heat above freezing is 1,120 British Thermal Units in one pound of vapor. If the temperature of the ocean water is 60 degrees Fahrenheit, then the heat wasted is 1,120 — (60 — 32) = 1,098 B. T. U. In an average-sized evaporator vaporizing 5,000 gallons of water in twenty-four hours we have 5,000 × 8 1-3 = 41,666 pounds, 41,666 × 1,098 = 45,749,268 B. T. U. of heat required in a day. Now assume coal having a heating value of 14,000 B. T. U. per pound, which fairly represents the best class; assume a boiler efficiency of 60 per cent., and loss due to radiation to be 10 per cent., then assume the efficiency of the evaporator to be 50 per cent., all of which figures are fair average thermal efficiencies as noted in actual practice. Then 14,000 × .60 × .90 × .50 = 3,780 B. T. U. delivered to the vapor for each pound of coal burned. Then 45,749,268 ÷ 3,780 = 12,103 pounds of coal, or over six short tons of coal, are required by the evaporator every twenty-four hours. By proper running this can be cut down considerably.

That evaporation may easily work at low pressures, the distiller should be placed about 30 feet above the evaporator. The condensed vapor will then gravitate to the little air pump usually provided, and the salt water will not be drawn up into the distiller when the evaporator is priming or is flooded.

When the fresh water is needed for the boilers, some engineers run the pressure up to 30, 40, or even 50 pounds, and run the vapor into the receiver of the engine; but this is a mistake, as the heat units were better to transmit direct from the boiler to the engine than to suffer the loss of efficiency through radiation and convection in the evaporator. The better way is to run the vapor direct to the condenser, and operate the evaporator at condenser pressure. Another way is to run the pressure at or a little above the atmosphere, and carry the vapor direct to the filter tank or hot well into the feed water. This saves all the heat, but must be carefully regulated so as to not boil and vaporize feed water where same is open to engine room. Probably the method involving the most practical efficiency is, to condense the vapor in the distiller at a pressure of 10 or 15 pounds above atmosphere, blow the air out of a cock in the top of distiller, and run condensation to feed-pump suction. In this way the feed water from distiller can enter pump suction at a temperature of, say, 245 degrees F., and but 912 B. T. U. will be thrown away by condensation. It is to be remembered that as little heat as possible should be given to the condensing water or other cooling agent.

The next important consideration is the blowing of the evaporator. Usually it is done intermittently, so that the pipes will not choke with salt, and also to flush them. Some evaporators blow direct, like a boiler. Of course, these cannot be worked below atmospheric pressure. Others have pumps to draw out the heavy brine which gravitates to them, and these can be worked at any pressure. Incidentally, a case is known of a young genius who used the evaporator to make the heavy, saturated brine for his refrigerating machine, and he got brine that would float a hydrometer at 96, which is almost impossible in the ordinary way.

The blowpipe should be as straight as possible, as salt is liable to block it at elbows and bends. Attendants with more important duties are apt to forget to blow evaporators, causing saturation, and precipitation of salt, necessitating cleaning. For this reason, as well as to keep up a slight circulation, it is better to have the blow always running a little. As a valve partly open is apt to gather salt, and as a slow-moving pump is liable to stick, it is good practice to have a small pipe to brine suction connecting with clear sea water, which may be used for keeping pump and pipes flushed and full, and thus also thin the brine. It must be so connected, however, that the evaporator will not be flooded when it is running at less than atmospheric pressure.

The blow has a most important effect upon the efficiency, because if it is left open too long the water will run cold and will not vaporize at all. There will be no external evidence of its condition. The gages will stand all right, and the machine will have every appearance of working, and still be below the boiling point and not vaporizing one pound of water. For this reason, one should learn to know the rumble or faint sound of boiling in a properly-working evaporator, and the silence of one in which the circulation is too fast.

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If the water is blown too low, so as to uncover the tubes, the salt will be baked on and be very hard to clean off. If the brine gets too heavy, that is, saturated, the salt will precipitate, forming a hard cake in the bottom, choking suction pipes, salinometer cocks, gage cocks, etc. For this reason, it is well not to place these fittings in the bottom, but rather to one side, as such an accident often entails great labor and loss of valuable time at sea. The feed should enter about two-thirds the height of the water level. It should be above the heavy brine in the bottom and below the main body of ascending steam bubbles. In this way the circulation is best maintained.

It is very important that the water level in the evaporator be maintained fairly constant, and this is accomplished by fitting automatic regulating contrivances. One kind has a float regulating the pump throttle; in another the float regulates the suction to feed pump by passing it to suction of blowing pump.

If the feed pump were to suck from the discharge of circulating water from distiller, many heat units could be saved, as this water can and should be discharged very hot, if the distiller is operated properly. The writer has seen the feed pump take all of this water, and thus effect a perfect saving. The circulating water need run only very slowly through distiller. While it has never been, to the writer's knowledge, done, considerable saving could be made by coiling part of the feed-pump suction inside of the smokestack. The distiller setting so high would make this especially convenient, and water could be delivered to evaporator boiling hot, as the temperature of gases in the stack is very high compared to the water.

Electric devices have been tried which automatically regulate the water level, but none have as yet been adopted.

The live steam is usually led to the evaporator at boiler pressure, a drip pipe carrying the condensation from the steam coil to a trap. Many engineers try to force their evaporators by passing steam around the trap. A little reflection will show that nothing is gained by this, as the steam is at the same temperature whether circulating or standing, the trap carrying off the condensation. Moreover, if nothing but condensation is taken away, all the latent heat in the steam is given over to the vaporizing of the salt water. If the evaporator were to work at boiler pressure, the difference of specific heat between salt and fresh water, the low pressure and boiling point in salt-water side, and high pressure and possible superheating of live steam, makes the fresh water vaporized greatly in excess of the steam condensed in evaporator and drained into trap. The amount of heat supplied by the boiler steam equals the amount of heat of the vapor discharged to the distiller, plus the heat given to the salt water, plus the heat lost by radiation.

In making fresh water for boilers only, it is common practice to turn boiler steam directly into the salt-water end of the evaporator. This is a very fast method, especially if the pressure be kept down to the pressure of main condenser, and vapor led there as fast as made. If forced too much, severe pinning and salting of vapor occurs. This method cannot be pursued when potable water is required for cook's tank or scuttle butt, as the oil from boiler steam is always present in sufficient quantity to spoil the taste.

Almost as good results can be obtained from running a properly-proportioned evaporator in the right way. When forced with boiler steam direct, oil fouls the evaporator and hardens the salt deposit, and is very hard to clean out.

In the United States Navy an evaporator of 5,000 gallons capacity per twenty-four hours is required to have a heating surface of 265 square feet in tubes alone, and 66 square feet of condensing surface in the distiller, which the author thinks should be increased to 265 square feet, that the weight of circulating water may not exceed feed water and hence be used for feed water.

At times the vapor in scuttle butt will become salty when evaporator may not have been flooded at all. This may be caused by the leakage of cold brine in the cooling coils. Refrigerating men should look after this closely, as it is very easy for the strong brine to eat a hole in an iron pipe. Another very good way to cool drinking water is to let a small jet of air from the Allen machine, if one be aboard, expand directly into the water at the bottom of the tank, and provide escape at top. Even such a jet from any ordinary compressor will cool the water and remove the flat taste. Baffle and distributing plates should be placed over the jets, else they will rise in a straight line to the surface.

Cleaning the evaporator, if it has to be done at sea, is a most abominable job at best. However, many things tend to ease the task—proper trolley or cranes, so designed as to hold stiff in heavy weather; half-round gouges with long handles to scrape tube; a square-end spade bent to fit bottom and sides of evaporator; and a convenient hydrant for fresh-water hose.

As regards the design of the distillers, the author has yet to see one large enough. They all choke the evaporator, causing it to run up to the highest pressure, thus still further hindering progress. It is perfectly possible for the pressure in the evaporator to equal the pressure in the live-steam coils, and many engineers do this under the mistaken idea that the machine is working at its fullest capacity, when in reality it is at its least.

A more free use should be made of the steam tables and theory of heat in looking up this subject. Aside from the economy, it is of vast importance that the evaporator be run at its maximum on our big passenger steamers, where the potable-water supply is small and large dependence is placed upon distilling plant. It is very serious to have the supply run short, or get flat, or oily, or salty.

Another necessity is to keep the water clear and the tanks clean, that clear ice may be made. Ice shows dirt, etc., because it all collects in the center of the cake. A small charcoal filter is an excellent installment in behalf of the ice man; and air should not be blown through water meant for ice, as it results in porous cakes.

The pumps are usually double-end, piston type, that is, one steam cylinder with a water cylinder on each side of it. The feed end should have metal valves and metal-packed piston, so as to feed hot water when so arranged. There should be no lead or copper here, because they both are slightly soluble in hot water and

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might, under favorable circumstances, taint the water. The end for removing the heavy brine should be especially protected against corrosion, and metallic valves used. Any pumps used for fresh water should not have lead or other soluble metal in contact with the water, as the water would be tainted.

When the boiler pressure is above 100 pounds it is the practice to use reducing valves, and use low pressure of, say, 60 pounds in the live-steam coils. This makes very little difference, since, when saturated steam is expended without doing work, or when, in other words, the pressure is reduced, the same amount of heat is present and the steam becomes superheated.

The evaporator nearly always has a safety valve, which, however, is seldom found in good order. Engineers forget that an evaporator explosion at 60 pounds pressure could wreck an engine room, induce larger explosions, and sink a ship, or scald the crew to death.

Salometer pots and cocks are usually provided and seldom used. They should be used freely. A most excellent device is a tube or large water-gage glass with a hydrometer floating inside of it. Every time the glass is blown it fills up with brine from the bottom, and a reading can be taken and the blow regulated for maximum useful effect and at the same time with minimum waste of heat.

Zinc plates should be provided in evaporators as in boilers, to guard against galvanic corrosion. They should be bolted firmly to sides, and bright electrical contact there made. Then a basket or pocket should partially surround them, to catch the zinc salts as they are formed and disintegrated from the plate. Another good practice is to have a water meter on the discharge to the fresh-water tanks. Its use is obvious and invaluable.

The brine and feed pump cylinder should be arranged to take steam from the topmost evaporator coils, to prevent their becoming air-bound. Lastly, but not leastly, shells are usually designed and tested for 50 to 120 pounds pressure, but few are designed and tested to resist the collapsing effect of atmospheric pressure.

The evaporator is merely one of the numerous auxiliaries which a little more study and care would make more efficient, useful, and indispensable to the commercially successful engineer.

Inquiry Concerning American Shipbuilding.—At the regular monthly meeting, held on June 11, of the Maritime Association of the Port of New York, a resolution was adopted providing for the appointment of a committee of five "to ascertain by what method ships built in American shipyards, officered and manned by American citizens, may most quickly and effectively secure the larger part of our foreign carrying."

The committee is to present its report to the board of directors no later than December 1, 1903. The association also declared itself opposed to the enactment of any law compelling sail vessels to carry licensed engineers for the working of the machinery used for handling the sails, anchors, etc., on such vessels, as the enactment of such law would add to the already heavy and unnecessary burdens now imposed upon sail-vessel owners.

German-Built Cargo Steamer.

As mentioned in the April issue of MARINE ENGINEERING, there are no less than seventy-one shipyards in Germany, some of them capable of turning out large merchant ships and war vessels, and others, smaller sizes, directing their attention to moderate-sized steamers. One of the most modern yards in the country is that at Flensburg, called the Flensburger Schiffbau Gesellschaft. Well located on a fjord of Kiel bay, it has turned out many large merchant ships and vessels of different classes during the last few years.

The cargo ship *Lichtenfels*, built for the Deutscher Dampfschifffahrts, Hansa, Bremen, by the above-named shipyard, embodies the latest practice of large economic cargo vessels. The length over all is 440 feet, the molded beam 53 feet 2 inches, and the depth to upper deck 33 feet 3 inches. The other particulars and dimensions will be found in the accompanying table. The vessel is being built and fitted out according to Lloyd's requirements and is provided with the latest improvements for rapid and efficient loading and discharging of cargo. As will be seen from the drawing, the *Lichtenfels* has a short poop, bridge, and forecastle, with deck house on the bridge with accommodations for the captain and officers. The cargo is carried in four holds and four 'tween decks. Each hold has a large hatch,

NAME—Lichtenfels. **NATIONALITY**—German. **TYPE**—Ocean Cargo.
LAUNCHED—1903. **BUILDER**—Flensburg Schiffbau Ge'. **OWNER**—Deutsche Steamship Company.

Length over all	440 ft.
" between perps	425 "
Breadth	53 " 2 ins.
Depth of hold, to upper deck	33 " 3 "
Launch displacement	2 900 tons
Load draft	24 ft. 10 1-2 i' s.
" displacement	12,220 tons
Dead-weight carrying capacity	8,000 "
Bunker capacity	1,355 "
Ballast tanks capacity	2,070 "
Engine	four-cylinder, quadruple
Cylinder diam	24, 34, 51, and 74 ins.
Stroke	54 "
Arrangement of cylinders and main engine:	H. P.; L. P.; 2d I. P.; 1-4 I. P.
Designed R. P. M.	65
" H. P	2,600
Type of valves, piston and double-ported flat valves	
Diameter of piston valves	13 1-2 and 16 1-2 ins.
Diameter of liners	16 and 19 1-2 ins.
Engine columns	cast-iron, hollow
Type of condenser	surface, built in back framing
Cooling surface	3 760 sq. ft.
Tubes, size	3-4 in. outside diameter
Air pump	Edward's patent, 28 by 28 ins.
Boilers	three single-ended and donkey boiler
Diameter	14 ft.
Length	12 "
Steam pressure	225 lbs.
Tubes, number	334 for one boiler
Size	2 1-2 ins. outside diameter
Furnaces, number	three for one boiler
H. S.	2,167 sq. ft.
G. S	49 " "
Draft	Howden forced
Propeller, number of blades	four
Diameter	19 ft.
Pitch	20 "
Developed area	103 sq. "

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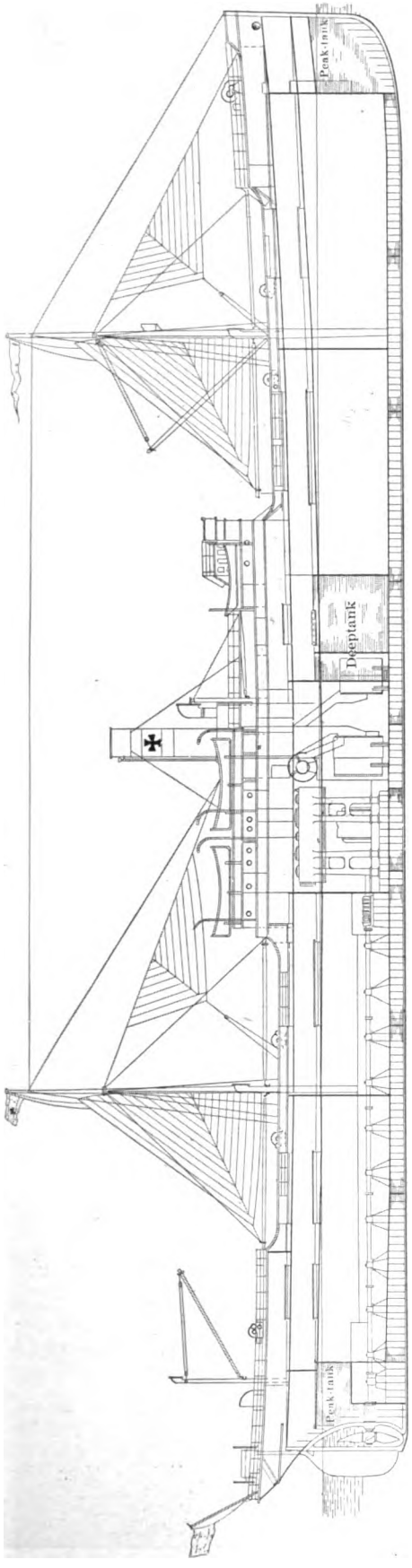

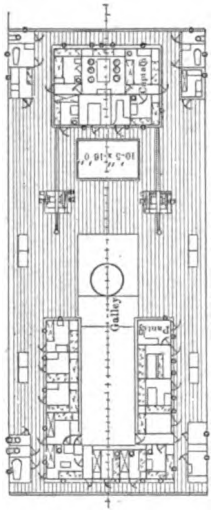

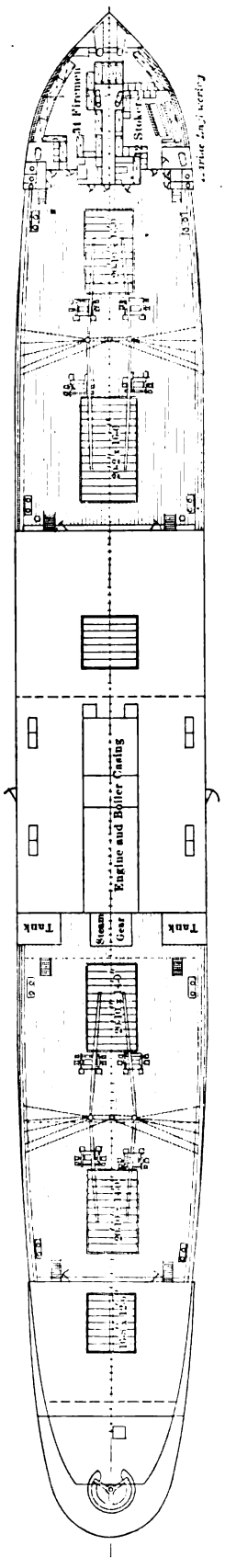

CARGO STEAMER BUILT BY THE FLENSBURGER SCHIFFBAU GESELLSCHAFT, GERMANY.

which is served by two derrick booms and two winches. In the plan it will be noted that the booms are mounted on short masts on either side of center line. Under the forecastle is a space for thirty-four sailors and firemen and twelve stokers. In the forward house, on the bridge deck, there are accommodations for the captain, pilot, a spare state room, and two store rooms and hospital. The special feature of the crew's accommodations on this deck are four small houses built at the four corners of this deck, containing the lavatories of officers and crew and the deck stores. Two winches are placed a little forward of the stack, for serving the hatch going down into the deep tank, which is directly forward of the boiler room. The house round the engine-room casing contains on the starboard side the pantry and mess rooms, on the port side are the officers' quarters, and at the after end the state rooms for engineers, etc. On the poop is placed a derrick mast and winch for loading and unloading the after hold. There are six cargo hatches on the spar deck—two forward, leading into the forward holds; one to the deep tank, as above men-

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tioned; two for the after holds and one under the poop. Two fresh-water tanks are placed aft the midship house, each containing 18 tons of water. Hatches are cut through the main deck, of the same dimensions as those in the spar deck, excepting that into the deep tank, where there are two small hatches. Wing and thwartship coal bunkers have capacity on this deck for 347 tons.

The water bottom is fitted from the forward collision bulkhead to the after peak tank. Wing bunkers round the engine and boiler rooms, below the main decks, can stow 310 tons of coal.

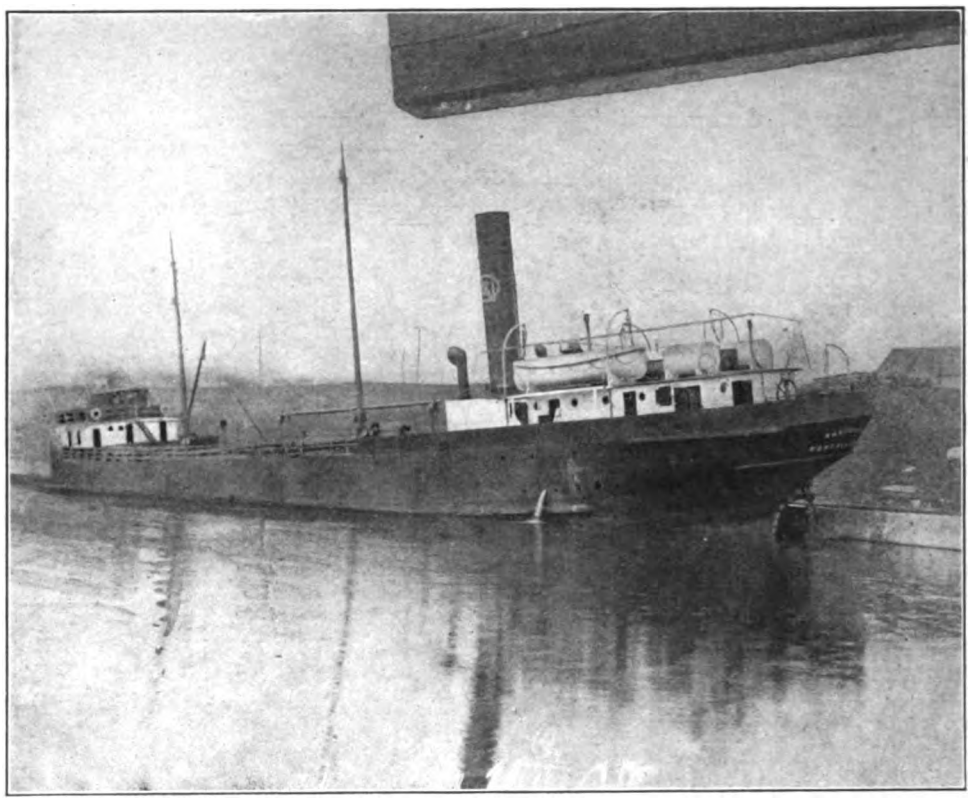
The ship is propelled by one set of quadruple-expansion, four-cylinder engines supplied with steam from three main boilers. A donkey boiler, placed in the recess in the forward bulkhead, may also be run at the same pressure as the two main boilers, namely, 225 pounds, but is installed mainly for taking care of all auxiliaries and the winches when the ship is in port.

Webb's Academy.—On June 11 the graduating exercises took place at Webb's Academy for marine constructors and marine engineers, sixteen students receiving diplomas. Addresses were made by Mr. Stephen Taylor, president of the Board of Trustees; Messrs. Harrington Putnam, Stephen M. Wright, and Rear-Admiral George W. Melville. The latter spoke on "Engineering as a Career, and the Attainment of Success." As the engineer is best qualified to understand and perform the largest and most important share of the world's work, he is called upon to act in the administrative capacity in both public and private affairs.

Steamer Sunk in Canal.

The steel freight and passenger steamer *Wahcondah*, built at New Glasgow, and the first of a fleet of ships for the new Ontario Steamship Company, came to grief at Farrin's Point canal below Prescott during the second week of May, through an eddy causing her stern to sheer while she was in a lock. Her bow struck with great force against the wall of solid masonry, with the result that she was damaged, eleven steel frames and four plates being torn away or bent. The vessel sank immediately in 17 feet of water, which of course, however, did not mean her going under the surface.

She was loaded with 1,500 tons of freight consisting of firebrick, pig iron, and pickles. The Donnelly wrecking firm, of Kingston, sent the wrecking steamer *Donnelly* and lighter *Grantham* at once to the wreck, and the water in the stranded steamer was quickly pumped out. Divers were then set to work, and when 200 tons of cargo had been removed the damaged part was sufficiently above water to permit of making temporary repairs.



STEAMER WAHCONDAH, SUNK IN FARRIN'S POINT CANAL.

With the pumps still on board for use in case of accident, the steamer proceeded to Toronto and Hamilton to discharge the balance of the cargo, and then went to Cleveland, where she will undergo repairs.

The *Wahcondah* is a new ship, the largest plying between Port William and Montreal, and is designed for carrying packet freight from Duluth to Montreal. The general dimensions are: Length, 245 feet; beam, 37 feet; draft, 17 feet. She is owned by Mackay Brothers and others, of Hamilton.

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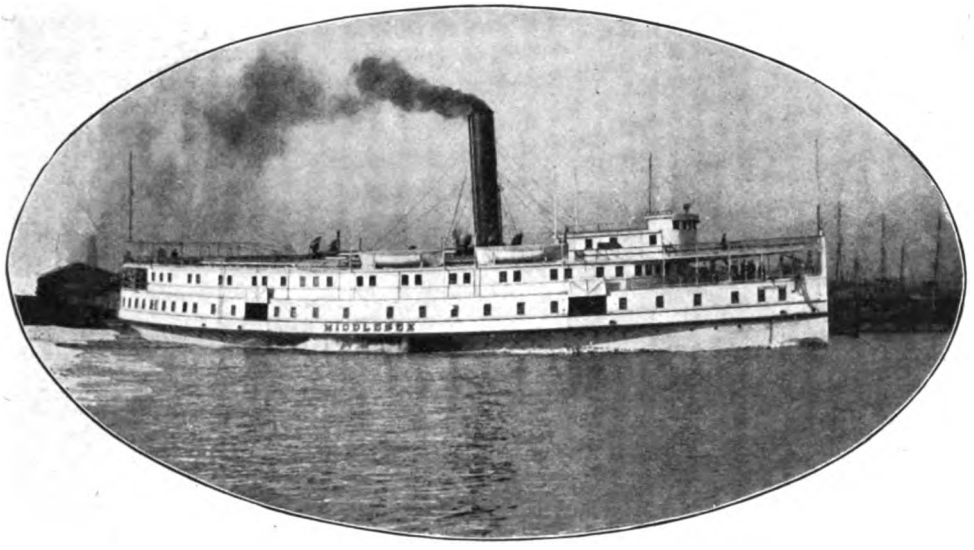

SIDE-WHEEL STEAMBOAT MIDDLESEX, OF THE WEEMS STEAMBOAT COMPANY.

NEW STEAMBOAT MIDDLESEX, FOR THE RAPPAHANNOCK RIVER.

The Weems Steamboat Company, of Baltimore, has just put the paddle steamer *Middlesex* on its Rappahannock river route between Baltimore and Fredericksburg, Va., for which she was built by the Neafie and Levy Ship and Engine Building Company, of Philadelphia.

Her principal dimensions are: Length over all, 207 feet; between perpendiculars, 200 feet; beam, molded, 36 feet; beam over all, 59 feet; depth from base line to top of beams at centre, 13 feet; depth at side, from base line to top of guard stringer plate, 12 feet 3 inches; sheer forward, 4 feet 6 inches; sheer aft, 2 feet. The contract called for a speed light of 16 miles, and 14 miles loaded with 50 gross tons of coal and 250 net tons of cargo, on a mean draft of 8 feet. A peculiarity of her construction is that from frame 55 to the stern post, a distance of 94 feet, the keel rises 18 inches.

The general arrangement of the boat is as follows: The space forward of the collision bulkhead is divided by a water-tight deck into a ballast tank of 18 tons capacity and chain lockers. On the lower deck, aft of the collision bulkhead, is a room about 17 feet long, fitted with 18 berths for deck hands and 6 berths in a separate room for stokers. The next 28 feet is the second-class cabin for men, fitted with 45 berths. This cabin, which is reached by stairs under the forward saloon stairway, also contains a room for the steward and one for the waiters and cooks. The hold takes up the remaining space forward of the boiler-room bulkhead. This hold extends under the lower deck to the collision bulkhead. The boiler room is about 22 feet long, extends the width of the hull, and is separated from the engine room by two athwartship bunkers of 60 tons capacity. A passage through the bunkers leads to the engine room, which is 42 feet long. Aft of the engine-room bulkhead are three cabins for women, containing 48 berths, and a room for the stewardess. These cabins are entered by stairs under the after saloon stairway. Under the cabins are two tanks holding 3,500 gallons of water for drinking and culinary purposes. All the berths on this deck are of pipe, and all ironwork is painted with cork. The remaining space aft is occupied by a trimming tank of 24 tons capacity, and is fitted with a water-tight flat forming the tiller room.

On the main deck aft is a large social hall for second-class passengers. The lockers and woodwork as high as the window sills are of oak. Above this the paneling is soft wood painted white. Two toilets and stationary washstands are provided. A passageway leads from this social hall to the freight space. On the port side of the passage are the bar and mail room. On the starboard side are the smoking room and purser's office. The after saloon stairway leads up from the smoking room. Aft of the port wheel box are the package room, ice box, and steward's stores. Aft of the crank room is a large galley, lighted and ventilated by a trunk extending to the hurricane deck. The entire galley and trunk are built of steel, and the floor tiled, making a fire-proof job. On the forward deck is a 6 by 6-inch Hyde steam capstan, windlass, toilets for the crew, and a room for boatswain's stores. The rest of the main deck is used for freight.

On the deck above is the main saloon, about 150 feet long and extending the width of the boat. The paddle wheel extends only to the under side of this deck. Forty-one state rooms, all outside rooms, open directly into the saloon. Most of these rooms are communicating, and are fitted with two berths each, patent washstands, electric lights, and call bells. The furnishings are of cherry. The four large rooms at either end of the saloon are fitted with double brass bedsteads. The saloon is paneled in oak, and furnished with heavy oak furniture upholstered in green leather. The dome, which extends well forward and aft, is finished in white and gold. A feature of the boat is the dining room, located amidships aft of the stack. This room is 32 feet long by 20 wide, and is raised to a height of over 12 feet by a second dome extending above the saloon dome. It is finished the same as the saloon, and, as at present

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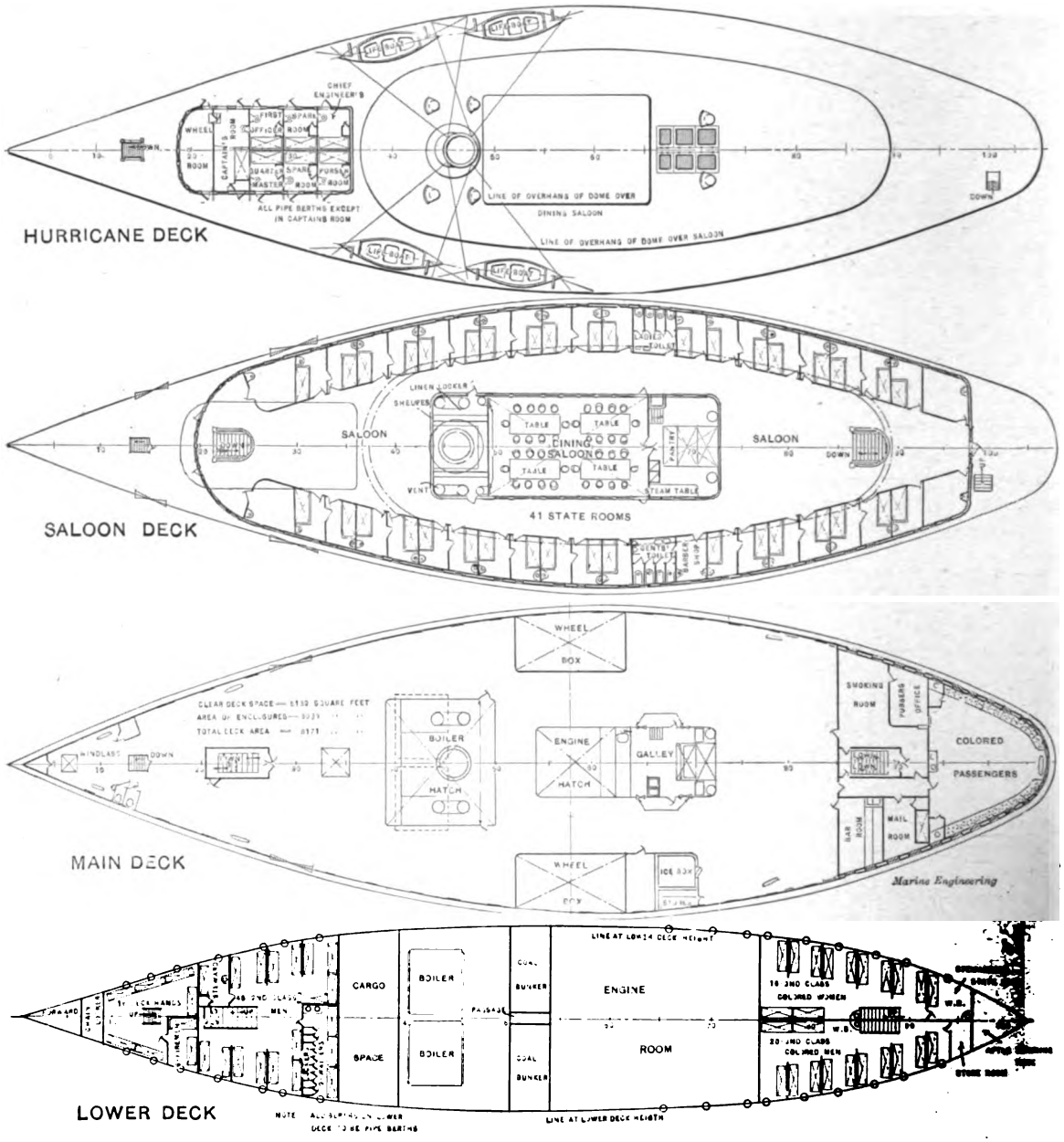
arranged, seats 42, although there is room for more tables if necessary. Aft of the dining room and directly over the galley is the pantry, fitted in the usual manner with serving table, dressers, sink, and two dumb waiters. On either side of the stack is a large linen closet.

The hurricane deck extends to the stem, forming a permanent awning over the forward saloon deck. The hurricane deck is open for the use of passengers, and is fitted with slat lockers forward and aft of the lifeboats, of which there are four, and two liferafts. This deck is reached by steps from the forward saloon deck and fantail. The pilot house contains only the wheel connected to the steam-steering gear. The hand gear is located aft on this deck. Aft of the pilot house are the captain's room, and six rooms for the officers, all of whom are berthed here.

The propelling machinery consists of a compound, surface condensing, inclined engine, with cylinders 24 and 53 inches in diameter and 84 inches stroke. The valves are of the double-ported slide type, worked by Stephenson gear with double bar links. The engine foundations are built of plates and angles in the form of box girders. The cranks, which are of cast steel, are placed at right angles. The shafting, connecting and piston rods, and valve gear are of forged steel. The wheels are of the feathering type, 13 feet 2 inches mean diameter, each fitted with nine curved buckets 8 feet 6 inches long by 36 inches wide. The engine was designed to indicate 1,300 horse power at 45 revolutions with 130 pounds steam pressure, and her speed and power in service are found to be practically the same as called for in the design.

All auxiliaries are independent. The surface condenser,



DECK PLANS OF THE STEAMBOAT MIDDLESEX, BUILT BY THE NEAFIE AND LEVY SHIP AND ENGINE BUILDING COMPANY.

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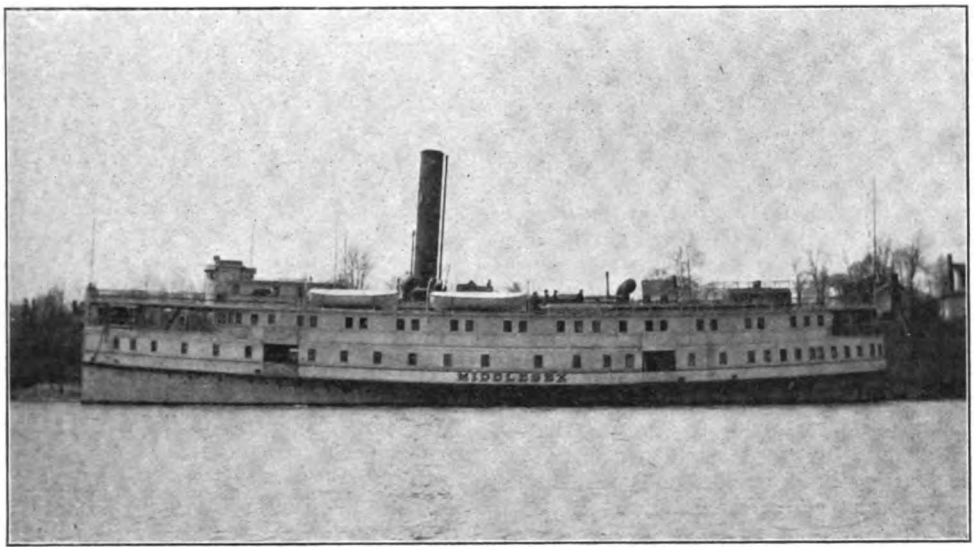
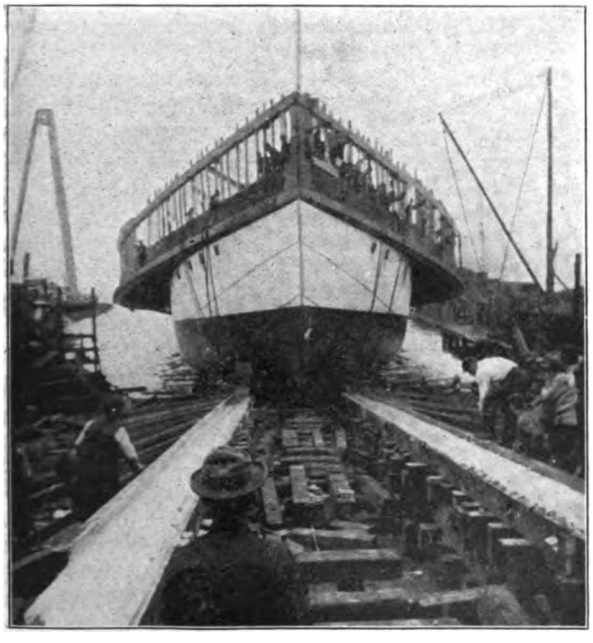
which is cylindrical and built of plates, contains 1,200 5-8-inch tubes 10 feet long. There is a centrifugal circulating pump driven by a single vertical engine, each fitted with three corrugated furnaces 44 inches mean diameter and 6 feet 10 1-4 inches long.

There is also a donkey boiler, 48 inches diameter,



THE MIDDLESEX AT DOCK.

a vertical duplex air pump, bilge, feed heater, and sanitary pumps. In the upper fire room is located a pump for assisting the circulation of water in the boilers. All



LAUNCHING THE MIDDLESEX.

the pumps are of Blake make. A Williamson steam steering engine is located in the forward end of the engine room. The electric lighting plant consists of a 17 1-2 K. W. Bullock generator, direct connected to a horizontal Sturtevant engine. A 14-inch Rushmore searchlight is located on top of the pilot house.

Steam is supplied by two single-end Scotch boilers 12 feet 9 inches diameter by 10 feet 6 inches long, built for 125 pounds pressure, located on the upper boiler-room grating.

NAME—Middlesex. NATIONALITY—American. TYPE—Paddle river steamer.

LAUNCHED—1902. BUILDER—Neafie and Levy S. and B. B. Co. OWNER—Weems Steamboat Co.

Length over all	207 ft.
" between perps	200 "
Beam over guards	59 "
" molded	36 "
Depth "	12 " 3 ins
Draft light	6 " 6 "
" load	8 " 6 "
Displacement, light	725 tons
" load	920 "
Block coef., load draft	.526
Engines	compound inclined
Cylinders	24, 53 ins
Stroke	84 "
Shafting diam	12 1-2 "
Condenser, surface	2,022 sq. ft.
Paddle wheels, diam. mean,	13 ft. 2 ins.
Buckets, feathering	curved surface
Buckets, number	9
" size	8 ft. 6 in by 36 ins.
" immersion at load draft	18 "
I. H. P	1,300
Revolutions	45
Boilers	two Scotch
Diameter	12 ft. 9 ins.
Length	10 " 6 "
Furnaces, 3 each, diam. mean	44 "
" length	6 ft 10 1-4 "
Tubes, 676, each	2 3-4 "
Heating surface 2 boilers	4,150 sq. ft.
Grate " 2 "	130 " "
H. S. ÷ G. S.	31.92
H. S. ÷ I. H. P.	3 2
I. H P ÷ G. S.	10.0
Speed, light draft	16 miles
" load "	14 1-2 "

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Suggestions to American Shipbuilders.

The public prints, both technical and lay, are constantly making comparison between the cost of building ships in the United States and in Great Britain. The result of such, expressed in dollars and cents, is invariably against this country, and remedies for such a state of things are as plentiful as the writers of the articles. To the writer of this communication it seems that possibly the fundamental reasons are two and may be stated as, lack of system, and the desire to get more than you are willing to pay for.

The lack of system referred to is shown by the acceptance by builders of specifications which do not specify, but leave open to the decision of the inspectors during construction point after point involving hundreds and, in some cases, thousands of dollars.

The second point brought out is shown in the decisions of the inspectors in such cases. Having the power in the absence of specification limitations, and feeling that their employers expect the very best and most expensive, whether required or not by the circumstances and future service of the vessel, the inspectors do not hesitate to use that power to its limit.

It is also an almost universal custom to insert in specifications what may be termed an "omnibus" clause, by which the builder is required to furnish or build any and all items considered necessary, whether or not specified or shown on the contract plans. The inspector is the judge, jury, and sheriff when this clause comes up for trial, as it does very often by the time the vessel is completed. The clause is misused as often as it is properly used, and may be held over the builder's head to browbeat him into furnishing that for which there is no other warrant in either specifications or contract plans.

As a result of this practice the owner gets a much better boat in many cases than he requires, and a better one than the money paid entitles him to, although that amount would have sufficiently paid for all that he needed. In other instances, where the builder has made an allowance for just this sundry item, the loss falls on the owner, who thus has paid for and obtained a yacht when all he wanted was a barge. The builder is "between the devil and the deep blue sea" when called upon to bid on a ship. If he makes his price on the basis of what the owner needs and *seems* to call for by the specifications, he will almost invariably come out of the little end of the horn on reckoning day. On the other hand, if he provides for such conditions in his bid, he will probably lose the contract, as his price is higher than that of others who either ignorantly or knowingly take the chances and trust to Providence to send them a good inspector.

While it would not be advisable to wipe out entirely the omnibus clause nor lock up the inspectors, it does seem as if the former might be so worded and construed as to perform the rightful duty expected of it, and then the inspectors' power should be confined to good workmanship along the exact lines laid down in the specifications. In order to do this it is necessary for the owner to decide in the beginning just what he wants and for the builder to have universal standard specifications for the various parts and appurtenances of ships. Unless all the principal builders will unite in this matter for the general good, it does not seem as though much can be accomplished, for the owner would quickly pass by the builder trying to tie him down in the beginning and go to one more lenient in the matter; but if he found that all responsible builders made the same demands, he would soon adapt himself to the conditions, and in the end come to consider the change to his advantage as well as that of the builder.

The limits of this article must necessarily be too circumscribed to enter into much detail as to what might be done in the line of standard specifications, but a few words can be devoted to the subject with interest and with perhaps some good.

Steel hulls are built usually under the rules of one or more of the classification societies. There are four such whose rules are adopted most generally, *i.e.*, American Bureau of Shipping, United States Standard, Lloyd's Register, and Bureau Veritas. It would, therefore, seem at first blush as though the requirement for standard specifications for this part of a vessel was fulfilled. It will be found that in the specifications, tests, and manner of inspection of the material there is great divergence between the societies. If this could be reduced to a common basis, it would simplify matters at the steel mills, and possibly work in the end to the cheapening of material slightly. There will also be found considerable difference in scantlings required and in the special local requirements. Also, into nearly all the books of rules issued by these societies are interwoven rules which are practically obsolete, while others, if construed literally, are more strict than intended, and oftentimes give to over-strict inspectors opportunities to require more than is intended.

The matter of carpenter work on the general run of ships is more open to trouble on the score of quality of material than any other point. This is especially the case with deck plank. If there were hard and fast standard specifications for the inspection of all lumber, dividing it into various grades, trouble would be avoided by having the standard grade desired embodied in the specifications for the vessel. The standard specifications should also include such lumber as is used for joiner work.

The matter of standards for joiner work would require a great deal of careful thought and work, but when once evolved would be the means of much saving in many cases. Such points as amount of paneling, depth and elaborateness of cornices, overhead ceiling, hard or soft woods, finishing, gilding, panel ornaments, etc., might be left to standardization and still leave room for different ideas of design and proportions. Furniture, such as chairs, tables, and desks, might well be considered under the head of joiner work, so that by having standard furniture the specifications become explicit by stating the exact number of each article to be furnished.

Hull fittings can also be standardized as to general design and material. There would then be various types of air ports, coaling scuttles, bitts, chocks, rails and stanchions, deck stanchions, hawse pipes, steering gear, etc., from which the prospective owner could make his choice.

Under the present methods, specifications often state that the vessel shall be fully equipped and furnished ready for service on such and such a route. Sometimes

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this is somewhat but not fully enlarged upon, but not often can anything more than a hazy idea be obtained as to exactly what is wanted. Standards for these items should include several types, graded from cheap outfits to the very best, such as finest hair mattresses, best all-wool blankets, china dishes, silver knives, forks, spoons, etc., best carpets and curtains, etc.

Sanitary fittings, such as bathtubs, closets, lavatories, and piping, are also subject to classification.

The propelling machinery might be readily divided into general classes. Many engines are now in service which have a much higher grade of finish in the way of polish, lagging, brass fittings, etc., than is necessary, or for which the owners would have been willing to pay if the matter had been called to their attention in the beginning. The following headings might be divided into types; boiler fittings, piping and valves (as to what class of pipes could be brass, copper, iron, or steel, and which classes of valves could be brass or iron), auxiliaries (as to how elaborate an outfit, whether pumps be brass fitted, etc.).

Of course, the above is only a general idea, and in the attempt to put into working shape it would undoubtedly be found that a great many departures from the outlined scheme would be advisable.

Under such a system as above the specifications for a vessel would be headed by a tabular statement somewhat similar to the following:

GENERAL SPECIFICATIONS.

Steel hull	20-year	A1
Main rail, yellow pine	Spec. No.	2
Main deck plank, Georgia pine	" "	1
Quartered oak	" "	5
White pine for joiner bulkheads	" "	7
White pine for joiner decks	" "	3
Joiner work (quartered oak and white pine)	Type	C
Air ports, 40	"	E
Coaling scuttles, 10	"	C
Bitts, 4	"	A
Chocks, 4	"	B
Life rails, etc	"	D
Sanitary system	"	C
Sanitary fittings	"	A

FURNITURE.

3 oak tables	Type	B
55 " chairs	"	D
5 " desks	"	A
Bedding	"	B
Crockery	"	A
Carpets and hangings, etc	"	B

MACHINERY.

Engine finish	Type	B
Boiler fittings	"	A
Piping	"	B
Valves	"	C
Auxiliaries	"	B
Lagging and covering	"	B

Such a schedule as this would be of inestimable value to all concerned. The builder would know what to bid on, and what to furnish upon securing the contract. The owner would know that all bids were upon the same basis, and could thus make a fairer comparison and more intelligently let the contract. The inspector would know exactly what his employer expected to get, and, if a lower grade of article or workmanship were called for, could accept it without being afraid of being hauled over the coals for not requiring the best.

Naval Engineering Experiments.—At a meeting of the Engineers' Club, Philadelphia, Pa., held May 2, 1903, Rear-Admiral George W. Melville read his paper on "The Military Importance of Naval Engineering Experiments" and detailed the scope and purpose of the Naval Engineering Laboratory to be established at Annapolis.

In calling attention to the surprising rise of Germany as a naval and maritime power during the past thirty years, the admiral stated that her excellence in the construction of warships and vessels is not the result of a progressive series of failures in design, construction, or operation. The success of Germany has resulted from study, reflection, and research in the preparation of plans, in the building up and organization of shipyards, and in laying out and carrying on the work of construction. It was the high appreciation of the value of experimental work and investigation that caused the progressive and successful advance.

The naval experimental work of America and England has been done in a desultory and sporadic manner. Thirty-five years ago Engineer-in-Chief Isherwood, U. S. N., carried on an extended and careful series of experiments in connection with the subject of screw propellers. The information secured at that time is standard authority to-day, but the problem as to whether or not in-turning screws are detrimental to manœuvering qualities would have been solved many years ago if the work planned by Mr. Isherwood had been continued. It is methodical, thoughtful, and persistent work which counts, and the engineering world is now beginning to understand the value of the work done at the Charlottenburg laboratory in promoting German success in naval construction.

Research should be conducted for preventing, rather than for remedying, evils, and there is not an eminent naval engineer in America or England who is not of the opinion that the establishment of a national experimental laboratory for naval purposes will contribute to military strength. For the past eight years the Bureau of Steam Engineering of the Navy Department has had in contemplation the establishment of such an experimental plant, as it can be absolutely stated that the Navy is behind the times in original work and research. The field to be covered by experimental research along engineering lines is vast, and Admiral Melville gave a few of the many urgent problems, in the solution of which the Navy has a direct interest. The primary reason and chief object for establishing the laboratory is to increase the efficiency of our naval service by preventing the adoption on our ships of war of untried or doubtful devices and expedients.

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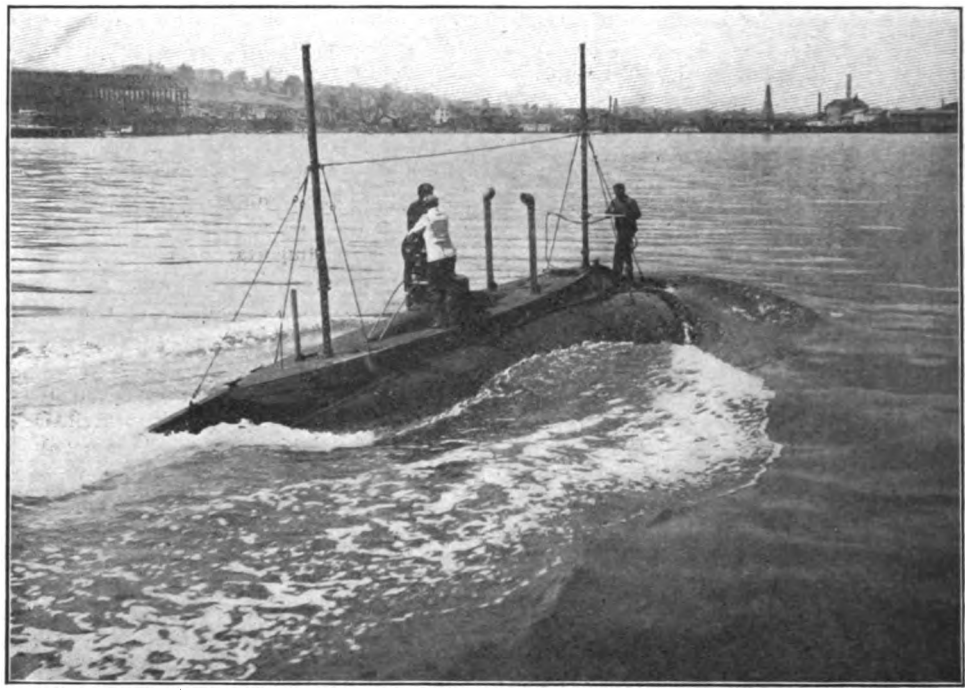
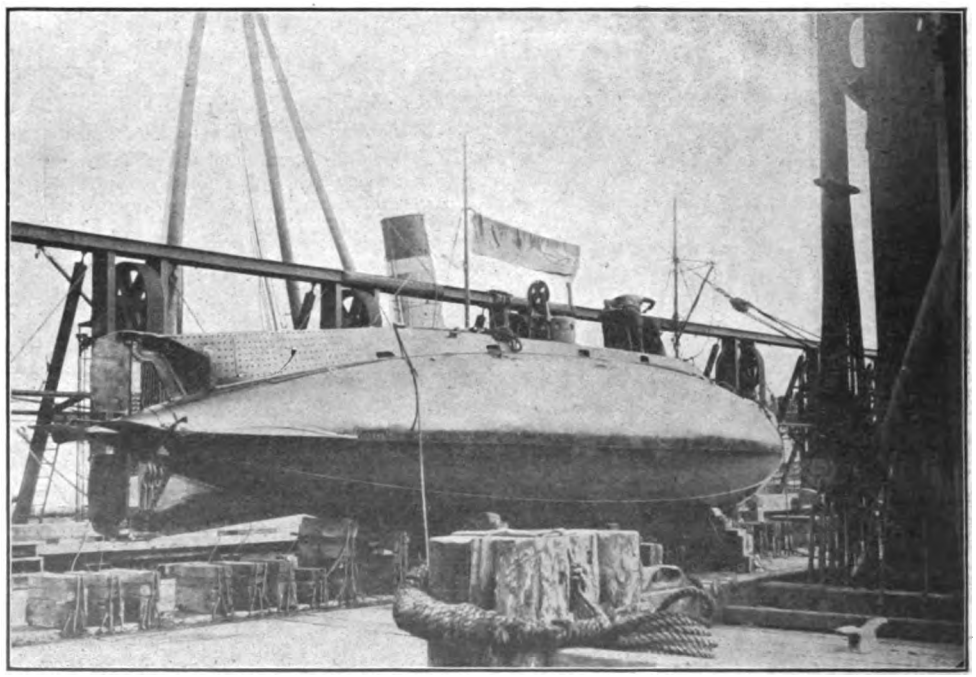
TRIALS OF THE SUBMARINE BOATS GRAMPUS AND PIKE.

The waters of San Francisco bay were recently ruffled by two most interesting craft, the first of their kind to be seen on the Pacific. They were the submarine torpedo boats *Grampus* and *Pike*, built at the Union Iron Works under contract with the J. P. Holland Torpedo Boat Company for the United States government. First, considering the general dimensions of these boats, they are 63 feet 4 inches over all, 11 feet 9 inches in diameter, and, when submerged, displace 120 tons. Power for driving the craft when on the surface is supplied through gearing to a single screw by a four-cylinder Otto gasoline engine of 160 horse power; any



STERN VIEW OF THE PIKE ON TRIAL.



STERN VIEW OF THE HOLLAND SUBMARINE PIKE.

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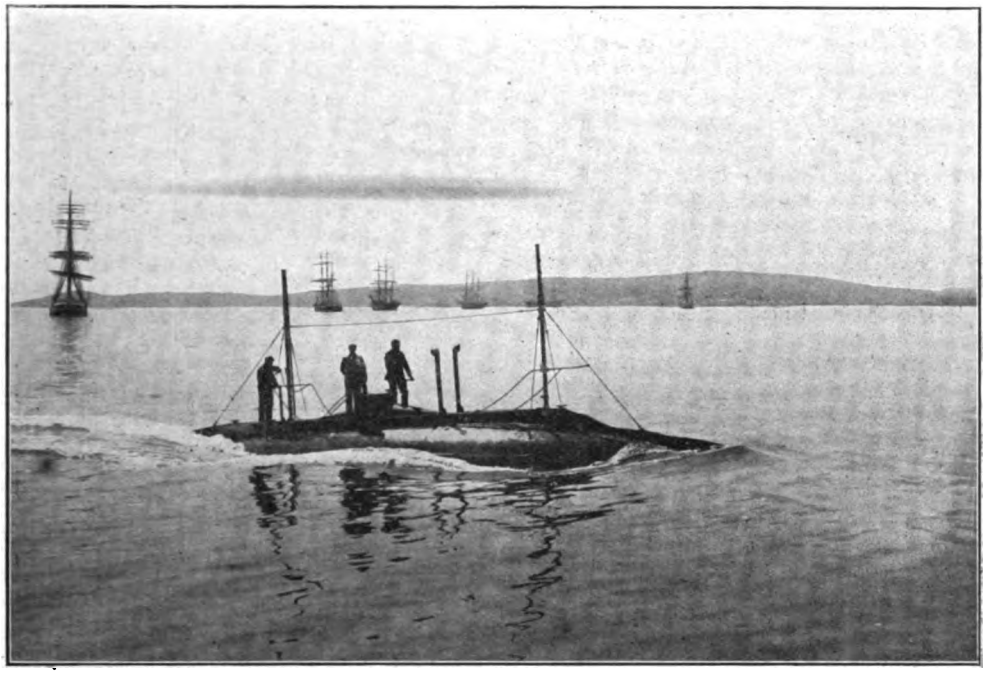
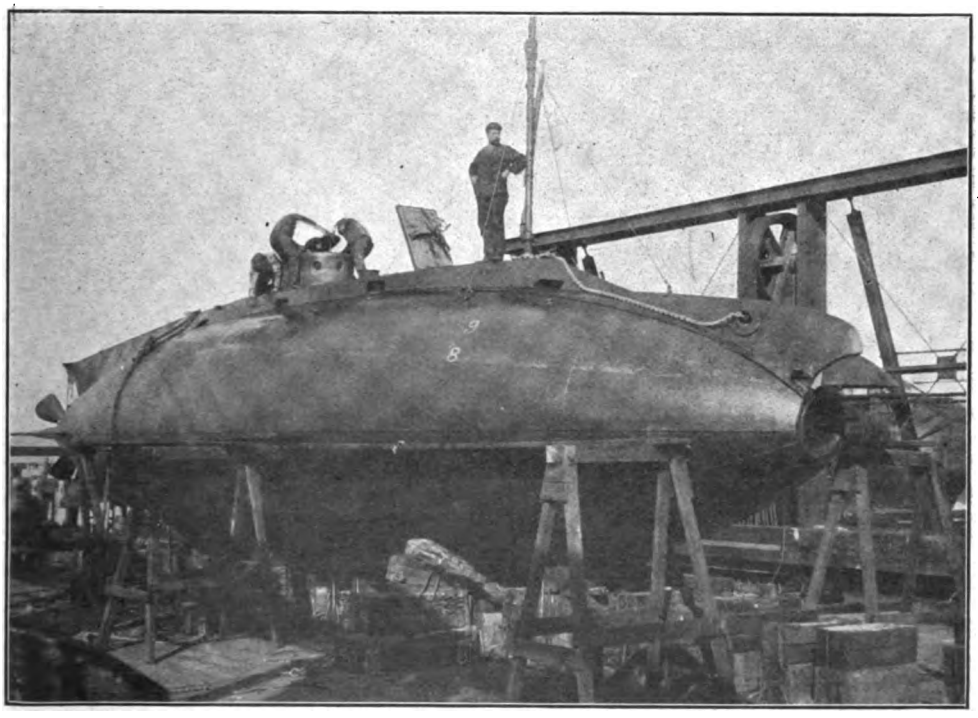
one or all the cylinders may be connected up at a time. When the boat is submerged, a 70 horse-power electric motor is geared to the propeller, the current being supplied from storage batteries rated at 1,840 ampere hours.



THE PIKE RUNNING HER SURFACE TRIALS.



THE HOLLAND SUBMARINES. THE GRAMPUS ON DRY-DOCK, BOW VIEW.

This motor is also used for coming alongside and making landings, as the gasoline engine does not reverse. The trim of the submarines is secured by 3 ballast tanks, one forward, one aft, and one amidships. When the vessel is to be submerged these tanks are filled with water until there is a reserve buoyancy of but 300 pounds, and then submergence is secured by means of diving rudders —horizontal rudders placed at the stern. To bring the vessel to the surface the water is forced out of the tanks by compressed air, and by means of the diving rudders.

In surface and awash conditions the vessel is steered from the deck, while the degree of immersion is

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controlled from below by the horizontal rudders. Ventilation for the long periods is reported to be rather bad, as might be expected.

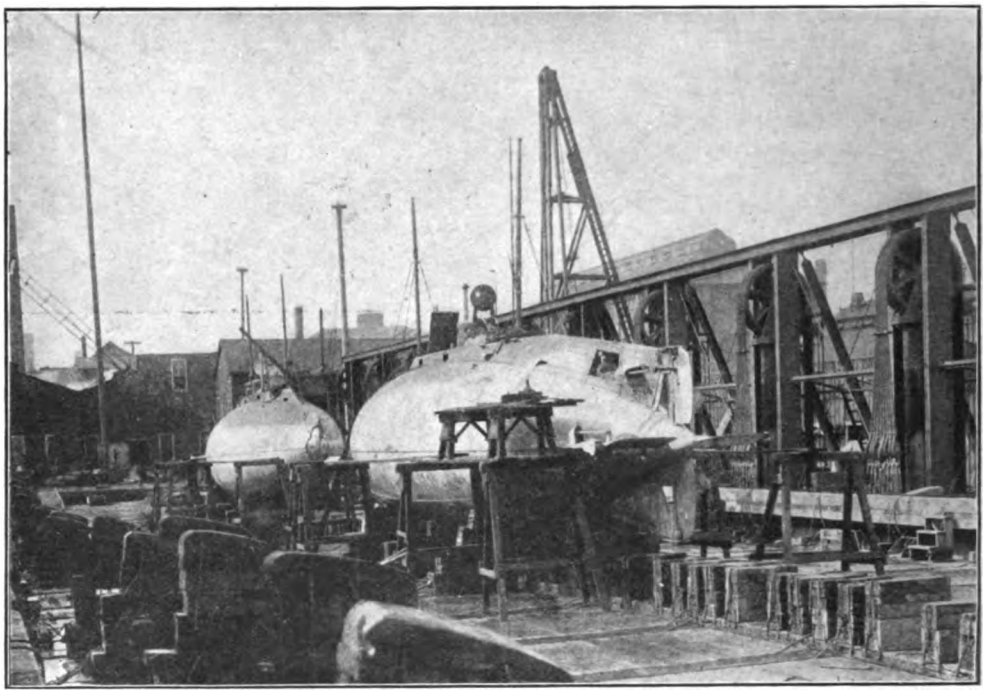
The course laid for the trial extended from a point near the Union Iron Works two miles across the bay toward Hunter's Point. Each vessel was first given standardization runs over one mile and half-mile divisions of the course. The trials, according to the contract, were most rigid, and were for testing the boat under all conditions of submergence. They first consisted, as already stated, of standardization surface runs in light condition, using gasoline engines alone. The contract speed was to be 8 knots, which was exceeded by about half a knot by each vessel. The weather conditions were perfect for these surface trials, as there was scarcely a ripple on the waters of the bay. A standardization run was next made by each awash, with two and three cylinders of the engine connected. The contract required a speed of 7 knots, while on both the *Pike* and *Grampus* the results gave a speed of about 7 1-2 knots. On these trials the boats were trimmed for diving, except that the main ballast tank was empty, the conning tower hatch cover was open, and the after ventilator in place.

The third trials consisted of standardization runs in completely submerged conditions, with the electric motor in operation. A speed of 7 knots was required, and this was exceeded at the first part of the run of each vessel, when the storage battery discharge was greatest. In making this run each submarine was trimmed, so that only the conning tower was visible, before starting on the run. Just as one reached the stake marks it would dive at an angle of about 8 degrees to a 16-foot depth. The course of the vessel could be followed by a little flag on the flagpole, and from this it was evident that the craft was remarkably steady and kept in constant trim. At the end of the run the submarine would come to the surface like a duck, take her bearings, make a turn, and dive upon her return trip. The diving and emerging were controlled by the horizontal rudders.

The fourth trials consisted of a surface run over a course of ten miles, and at a speed of not less than 8 knots. In these trials the *Pike* made 8.55 knots and the *Grampus* 8.47.

Then followed an awash speed trial, when the *Pike* made a speed of 7.65 and the *Grampus* 7.54 knots.

The sixth trial was for testing the torpedo-firing qualities, and, as laid down, each little boat had to run submerged for two miles at an average speed of not less than 7 knots, and fire a torpedo at a target at the end of the run. On April 7 the *Grampus* started on this trial, rising twice en route for observation, and at the end of the run rose to the surface and 25 seconds later discharged her torpedo at the target, 175 yards distance. The torpedo moved in a straight track and passed between the buoys constituting the target.



THE GRAMPUS AND PIKE ON DRY-DOCK AT THE UNION IRON WORKS, SAN FRANCISCO, CAL.

On April 4 the *Pike* was run through a similar trial, rising twice for observation, but failed to make a hit at the target, 200 yards distance.

For the two endurance trials the board selected the *Pike* to represent the *Grampus*, as the latter had given most satisfactory results. The trials consisted, first, of a 3-hour, completely-submerged run, under the electric motor only, and at a minimum speed of 7 knots, and then a 12-hour endurance trial for the gasoline engine. The boat was actually submerged 2 hours 31 minutes and 39 seconds, during which time the maintained speed was 7.07 knots; the rest of the time was required for surface observations, which took from 3-4 of a minute to

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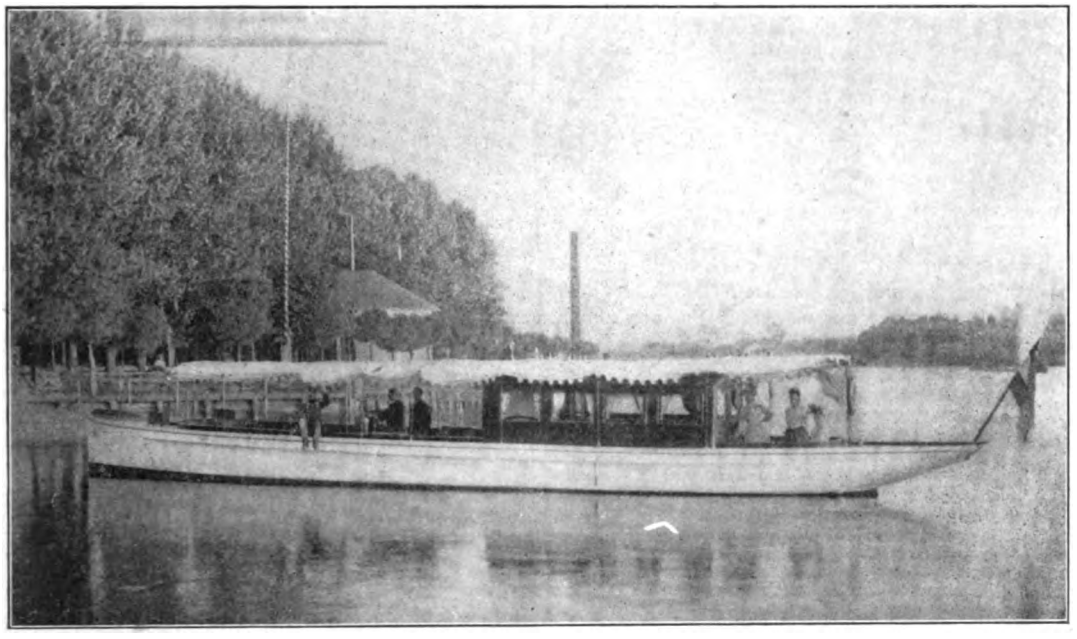
5 minutes each. The only part of the vessel visible during submergence was the periscope used for scanning the sea ahead. Mirrors are so set that objects ahead are reflected through a tube down below into the vessel, where they may be seen by the navigator.

The first part of the surface endurance run was made with the vessel under way, sailing on the surface, when the engine was disconnected and the electric motor thrown in gear to come alongside of dock. Then the trial was continued with the boat moored to the dock, with all cylinders of the gasoline engine in operation.



ELECTRIC LAUNCH GERMANIA.

German, English, and American Electric Launches.

BY FRANK C. PERKINS.

I.

The electric boat and launch industry has been rapidly developing during the past decade, and has now reached a place of importance in Germany as well as in England and America. Many people do not realize the prominent place taken by the electric launch, considering this class of yacht only serviceable with modern expositions. It is true that the expositions have done much to show the beauties of these marvelously clean, rapid, and roomy little boats.

As far back as 1891, at the Elektro-Technischen Ausstellung in Frankfurt a. M., Germany, there were two large electric boats in operation. One of these boats was known as the *Elektra*, and was exhibited by Siemens and Halske, of Berlin, and the other, the *Zurich*, by the Maschinenfabrik Oerlikon, of Switzerland. These electric launches were used for carrying passengers on the river Main, at the Frankfurt exposition, and were much larger than those at any of the recent expositions at Paris, Chicago, or Buffalo.

The *Elektra* was of steel plate construction and was built by R. Holtz in Harburg a. d. E. It measured 37.7 feet in length and 6.6 feet in breadth, and was equipped with a 10-horse-power motor and a Tudor storage battery of 80 elements, with a capacity of 140 ampere hours at a 35-ampere discharge rate. This was a 2.8-ton boat. The *Zurich* was also built of steel, at Zurich, Switzerland, by Escher-Wyss and Company. This launch was 49.2 feet in length at the water line, 52.5 feet on deck by 10.2 feet beam, and was equipped with an 8-horse-power motor operating at a speed of 350 revolutions per minute. The storage battery consisted of 56 elements of the Oerlikon type in glass receptacles. The storage battery had a capacity of 450 ampere hours at an 80-ampere discharge rate, and the boat was able to attain a speed of 5.4 knots per hour. After the Frankfurt exposition was over the *Zurich* was purchased by the Allgemeinen Elektricitäts-Gesellschaft, and was re-named *Elektron*. The Oerlikon storage cells were then replaced by others of a capacity of 350 ampere hours built by the Accumulatoren Fabrik A. G. of Berlin.

Two smaller electric launches, the *Watt* and *Matilda*, were constructed for this concern, 28.9 feet in length, 6.2 feet beam, and each was equipped with a 3-horse-power motor; each battery consisted of 46 elements of a capacity of 150 ampere hours at a 30-ampere discharge rate.

It may be of interest to consider some of the details of construction, with drawings and photographs, as well as electrical connections, of some of the more modern boats constructed in Germany by the last-named company; in England by the Thames Valley Launch Company, Ltd., of Weybridge, Surrey; and in America by the Electric Launch Company of Bayonne City, N. J., showing characteristics, outlines of the yacht, and the arrangement of the electrical equipment. The German builders of electric launches adopted two or three methods for the control of the electric motors. One of these consisted of an electrical controller mounted in such a position that its shaft is horizontal, the wheel by which it is manipulated being mounted on a shaft which is

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concentric with that of the steering wheel. Another method of control, particularly for large boats, is that using a lever which is thrown forward or back, according to the motion of the boat desired. A form of switch is also used with a vertical shaft, to which the contacts are fastened, the handle traveling in the arc of a circle.

The Hamburg harbor police and the Hamburg-American Line have electric launches similar to the *Marie*, length over all, 39.4 feet; beam, 6.9 feet. The *Marie* is in use upon the river Weser at the port of Bremen, and is equipped with a 12-horse-power motor and 92 cells of storage battery.

The electric launch *Oder* is 38.1 feet in length, has a breadth of 7.6 feet and a draft of 3.3 feet. It is in use on the river Spree near Berlin, and has a motor of 8-horse-power capacity. These electric boats are extensively used for Berliner Wasserbau-Inspection. The storage battery equipment of this boat includes 80 cells, having a weight of 4,580 pounds, with a capacity of 15-horse-power hours at a one-hour rate, and will develop 2.4 horse power for 10 hours.

Another electric boat, named the *Spree*, is used at Berlin for river inspection service. It is equipped with a 4-horse-power motor which is operated by 80 storage cells of the same capacity as the *Oder*. The dimensions of the launch are: Length over all, 30.3 feet; beam, 5.8 feet; and draft, 2.3 feet.

At the Hamburg port of the river Elbe a well known crane company operates the electric launch *Quaiverwaltung*, which is equipped with a 12-horse-power electric motor and has a draft of 3.1 feet. It has a total length of 40.7 feet over all, with a beam of 7.6 feet, and the storage battery installation consists of 200 cells.

The *Germania* is a much larger boat than those previously described, and is equipped with a 50-horse-power electric motor. It has a length of 64 feet, with a beam of 9.2 feet and a draft of 2.9 feet. The displacement is 17.5 tons, and it is equipped with 90 cells of storage battery having a capacity of 450 ampere hours at a 6-hour discharge. The maximum discharge rate for these cells is 150 amperes.

Among the other recently-constructed electric boats may be mentioned the *Nimpf*, built for Herrn Van Houton, of Weesp, near Amsterdam, Holland, and the *Havel*, which is in operation on the Potsdam lakes near Berlin. This launch is equipped with a 4-horse-power motor; is 29 feet long over all, 5.8 feet beam, and draws 2.6 feet of water.

A number of electric boats have been constructed in Germany for the harbor inspection at Rotterdam, Holland, and Stockholm, Sweden. One of the latter is a large boat known as *Tre Kronor*. It has a total length of 20 metres, and is equipped with a 20-horse-power motor. The battery consists of 45 cells, and it has a total displacement of 67 tons. The speed of the motor is 6 knots per hour, and the battery will supply 13.5 horse power for a period of five hours.

Without question there is a wide field for electric boats in connection with the navies of the various countries, as well as the police, customs, and harbor inspection departments of cities located on important bodies of water. There is also a wide field for this class of boat as pleasure craft, and at present they are being more largely used for this service.

Replacing a Slide Valve with a Piston Valve.

BY J. P. BADENHAUSEN.

It is generally recognized that piston valves are superior to flat slide valves in the high-pressure cylinder of a modern triple-expansion engine, even if a flat slide valve is supplied with a relief frame on the back and a balance piston to assist moving the valve.

Of course, speaking from the economical standpoint of steam consumption, the flat slide valve reduces the cylinder clearance considerably beyond that obtained by the piston valve, but for minimum of repairs and all-around good working the piston valve is superior to the slide valve. There is running to-day to the port of New York a steamer of 3,500 tons, built by one of the best English shipyards, which has an engine of 2,500 I. H. P., the high-pressure valve of which was a flat slide valve. The particulars are as follows: The engine is a three-cylinder triple-expansion, with cylinders 26 1-2, 45 1-4, and 75 inches diameter by stroke of 48 inches and revolutions 80 per minute. The boiler equipment consists of two 3-furnace single-end Scotch boilers, 15 feet diameter and 12 feet long, equipped with the Howden system of hot forced draft; steam pressure is 180 pounds gage.

All valves on the engine cylinders were of the double-ported, flat slide valve type without relief frames on back, having balance cylinders on the intermediate and low-pressure valve stems to assist. The high-pressure valve stem was without a balance piston even. The valves are driven by Hackworth's gear. The pressures in the valve chests are as follows: 180 pounds in the high-pressure, in intermediate receiver 65 pounds, and 15 pounds in the low-pressure receiver.

The size of the high-pressure valve was 27 by 20 inches, with an area of 810 square inches, and the pressure on the back of the valve was approximately 180 pounds—65 pounds=115 pounds per square inch. The total pressure on the back of the valve is therefore 115×810 square inches=93,150 pounds, or 46 1-2 short tons, and the throw of the valve, or valve travel, was 6 inches. In the Hackworth gear, as with nearly all radial gears, the connecting rod from the slipper to the end of the valve stem is very long, and in this particular case the action of the engine was very peculiar under different circumstances. When the engine was turning up at full speed and the valve was allowed to run without cylinder oil, this long connecting rod would vibrate and the valve would grunt in such a manner as to cause the decks, and the whole ship in fact, to vibrate in unison with it, and sleep for the landlubbers on board was next to impossible. The engine would slow down as much as seven revolutions.

When cylinder oil was used, and used copiously, the difficulty would disappear and the engine would speed up. Of course, this oil passed into the condenser and the boilers, with the result that the condenser would in a year's time become so dirty as to necessitate the drawing of the tubes for cleaning, while the oil in the boilers was conducive to priming and eventually caused trouble. To decrease the friction of this slide valve, the makers in England sent over a new valve, which had the face full of 7-8-inch dovetailed holes filled with white metal. This is an old trick, but worse than useless, as was proven.

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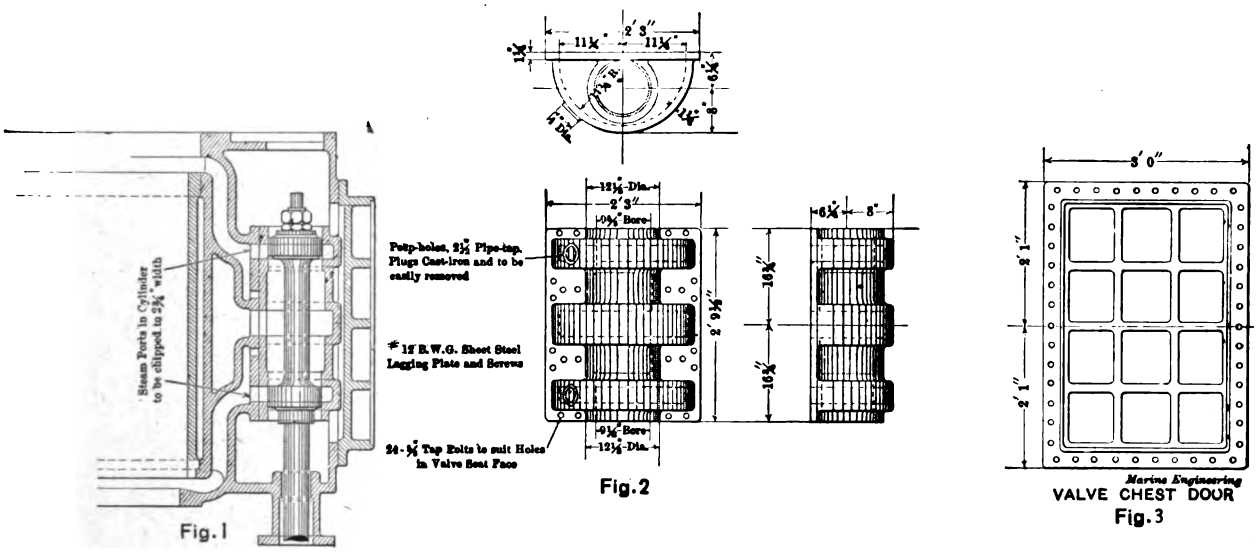
The minute the engineers failed to supply the engine with cylinder oil, the large friction of the valve upon the false face produced immense heat, which resulted in melting out the white metal, which was carried to all parts of the three cylinders and chests. The friction area being produced through the loss of the white metal, the valve worked harder and harder, and at the end of four months had to be renewed. After that a new slide valve was fitted every eight months, which in itself was quite an expense. It was suggested to substitute a piston valve for the flat slide valve, but there was one drawback, namely, the slide valve was double-ported; and double-ported piston valves, while they may do in land engines and electric light machinery, are not considered good for marine work. How the problem was eventually solved, and with the use of a single-ported piston valve, was as follows:

cannot be exceeded, as the center line of the valve stem must remain the same.

In most cases where piston valves are put in place of flat valves, the plug valve is the best to be used; and if so, then, as said before, the areas for the steam reaching the top and bottom plugs must be ample. The exhaust is taken care of by the middle part of the cage, and it was not necessary to restrict the areas.

The piston valve was designed to meet the same conditions as the flat slide valve, the throw of the eccentric remaining the same, and the travel of the valve being 6 inches, steam lap and exhaust lap to be the same as before.

The valve and its details are the same as are generally met with and need no description. As there was no bonnet on the old slide valve, means had to be adopted for getting the valve in place. The top of the



VALVE CHEST, VALVE, AND DOOR OF A HIGH-PRESSURE VALVE, USED TO REPLACE A SLIDE VALVE.

The cylinder and valve gear up to the valve stem were to remain as before, and the center line of the valve stem was not to be changed. Also, the piston valve was to be single-ported, to take steam at the ends and exhaust at the middle, and was to be put in in such a way as to be drawn out at the top in the ordinary manner. Figs. 1 to 3 give the detail drawings. The steam ports in the cylinder were each 1 3-8 inches wide.

The false face was taken off and the top and bottom ports chipped to be 2 3-4 inches wide each. The valve cage, Fig. 2, was bolted on the cylinder in the place of the previous false face, and the cage covered up the ports near the middle line of the cylinder; thus only the ports on the top, each 2 3-4 inches wide, were open. This cage was fastened to the cylinder by 24 tap bolts, 7-8 inch, fitted into the holes already in the cylinder. In designing such a cage care must be taken to leave steam passages at least equal to the area through the steam ports, so that there will be no wire-drawing. Peepholes are placed to assist in setting the valve.

The calculated diameter of the piston valve is 9 1-2 inches, which compares favorably with other engines having the same particulars of engine. This diameter

valve chest was cut away with a boring bar, and a 10-inch hole made, which allowed ample room for inserting or drawing out the new piston valve. A casting was bolted on top of the valve chest, the joint being a permanent one, and held on with eight 1-inch through bolts through the valve chest top, and five 1-inch tap bolts to the flange. A round cover was fitted on top of this casting in the regular fashion, and held down with eight 1-inch studs. If it is necessary to draw out the valve for overhaul, the work may be done in the same way as if the cylinder never had anything but a piston valve. With these new changes made, a new flat slide valve will be saved every eight months, the oil consumption will be cut down to one-fifth, and the engine will make at least five revolutions more than when the slide valve was in place. Nowadays, with the high steam pressures in vogue, it is necessary to run across a job like this ship to find out the difference in working and expense between a flat slide valve and a piston valve.

Liquid Fuel.—The British cruiser *Bedford*, it is reported, is having eight boilers fitted for burning oil fuel.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

AT the time when the formation of the United States Shipbuilding Company was announced reference was made to the fact in these columns, and to the field of usefulness which would seem open to such an organization, equipped as it was not only for the building of ships, but for the making of guns and armor as well. The most skillful of the plans of modern financiers, however, have in them something of the experimental and something of the unknown, and it now appears that the plan of organization first adopted was not the best suited to the needs of the situation, and at least two plans of reorganization have recently been proposed for the purpose of placing the company on a better basis for carrying on its business. It appears that from the first the company was compelled to make advances to its constituent companies from time to time of most of the cash in hand to meet the various demands for cost of operation and for working capital. It appears, further, that by reason of large mortgage obligations its credit has become impaired, so that some new adjustment is required in order to meet outstanding obligations and to provide for carrying on its business.

Shipbuilding, especially, is a business calling either for a large reserve capital or for excellent credit. Returns come irregularly, and sometimes at long intervals, while the outgo for labor and material must be sure and continuous. Under these various circumstances it is not surprising that the company has been brought to face the need of some readjustment which shall better suit the situation than did the original organization.

Undoubtedly one of the serious difficulties with such organizations lies in the temptation to capitalize on the basis of earning capacity rather than of actual value invested in the plant. This is a temptation hard to resist in times of business prosperity, when the earning capacity is large and corresponding dividends seem well assured. It is, of course, unnecessary to point out the danger and unreality of capitalization on such a basis. In the present case the fact that the original capitalization was for about $82,000,000, while in one of the plans for reorganization the proposed capitalization was but $43,000,000, shows at least a wide divergence in the basis of capitalization in the two cases.

Connected with this general question of the combination of shipyards is that of the trade condition and outlook at the time. With the yards full of work and more offering, perhaps almost any form of organization would be suitable; but with the yards working at only a fraction of their capacity, and with the outlook for the future somewhat uncertain, if not depressing, only the most judicious and conservative form of organization could hope to be adequate and safe. There is no doubt that the trade situation has had its influence in bringing about the troubles with which the United States Shipbuilding Company has had to deal. Unless we are mistaken, the amount of work in its yards as a whole has steadily decreased from the organization of the combination. That is, new contracts have not been forthcoming in sufficient quantity to offset the completed work, and the outlook for the immediate future is none too encouraging. Just now, indeed, outside of government work, the yards on the entire Atlantic coast are only occupied to a small fraction of their capacity. This general trade condition, which, on the whole, has not improved since the organization of the company, has doubtless greatly complicated the problem of a satisfactory form of combination for shipyards doing business under the conditions as they prevail in the coast yards at the present time. Whatever may be the ultimate solution, it is clear

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that the present shipbuilding situation and outlook is not one which will bear any inflation or capitalization on an artificial basis. With fixed charges based on the value of the investment actually operative and fruitful, with dead wood pruned away, with a series of constituent companies each sound in itself and carefully managed in detail, with a conservative and wise central administration, with a reasonable amount of work offering to keep the various constituent companies advantageously occupied—with these various conditions fulfilled there seems no reason why a shipbuilding combination should not be as successful as any other like business aggregation; and with constituent companies having the varied possibilities of the United States Company, there seems every reason for predicting for such a combination a career of usefulness and success. We trust that the troubles in connection with the present combination will not react disadvantageously on the constituent companies, and that whatever the outcome of the plans for reorganization, the results may be such as to affect favorably the trade situation as a whole.

THE dependence of the shipbuilder on the maker of the material which he must use has been frequently referred to in these columns, and we have pointed out the great need of some better commercial relation between the two in order that the builder may obtain his material within some reasonable approximation of the date when needed. These remarks have referred chiefly to mild steel material in the form of plates, shapes, etc., as used in hull construction. At the present moment we desire to call attention to another class of material, cast steel, in which there is great difficulty not only in obtaining desired delivery, but with the quality of the material as well. The question of delivery on time is part of the general trade situation in the steel business, and can only be corrected by a more evenly balanced relation between supply and demand, while in the meantime the builder is the one chiefly to suffer. We desire here to call attention rather to the quality of such material, sometimes so poor as to be of no use after delivery, such defects often not appearing until a considerable amount of work has been spent on the piece in the shops.

Aside from the question of test strength and the rough and seamy appearance of steel castings, the chief trouble arises from small concealed blowholes, sometimes in such great numbers as to render the piece quite useless for the purpose desired, and only discernible after a considerable amount of time and labor has been expended on them. It is true, of course, that the art of steel casting is one of the very greatest nicety and difficulty, and that there are some steel foundries where such art is well understood and where the product is quite uniformly satisfactory. It is no less true, however, that there are other foundries where the art is less perfectly understood, or where press of business leads to a neglect of some of the needful precautions, with the result that the attempt to use cast steel only too often becomes the source of most vexatious and costly delays. It is not alone in large pieces that such trouble is met with. In fact, it would seem to be on the whole more commonly found in small pieces, where perhaps the small size and simplicity of form may have led to some relaxation of the precautions taken with larger and more complicated pieces. Be the explanation what it may, the fact remains that in some yards there is observable a reaction against the use of cast steel and a tendency to return to the heavier but more reliable cast iron. Difficulties of the character mentioned have been met with largely in pipe flanges and fittings, small parts of the engine, such as link blocks, crosshead slippers, pillow blocks, and even in pistons and other larger items.

The situation itself is perfectly clear, and it is very unsatisfactory to the builder of marine machinery. The problem of what should be done is less easy of solution. From the results which are obtained from some of the leading steel foundries it appears that satisfactory and reliable material can be provided; there is no physical impossibility in the way, and it only calls for a proper observance of all the conditions needful. From the standpoint of the builder, therefore, the poor results seem to be due either to incapacity or to carelessness, or perhaps to both. What is very much needed is such improvement in the process of steel casting as shall make readily possible the production of a thoroughly reliable product without undue increase of labor or time involved. The demand of the hour from this particular point of view is for a product which shall fill the needs for which cast steel is now employed, and which shall be as reliable and uniform in character as the better grades of cast iron or brass. The cast steel founder who can fully realize these requirements, especially for small parts, and at what shall seem a fair price, will be justly considered a benefactor to the engineering public, and they will be only too willing that he should make the fortune which would be his just and certain reward.

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Death of Henry G. Morse, President New York Shipbuilding Company.

Henry G. Morse, president of the New York Shipbuilding Company, Camden, N. J., was stricken with apoplexy in the office of J. P. Morgan and Company, in Wall street, on the afternoon of Tuesday, June 2. He was removed to the Astor House, and died there in about a half hour.

Mr. Morse went to Mr. Morgan's office at about 2 o'clock, and, after talking with Edward T. Stotesbury, a member of the firm, went away. He walked a short distance up Wall street, met a friend, and with him returned to Mr. Morgan's office and asked to see Mr. Stotesbury again. He was shown into a back room, and, when Mr. Stotesbury came in, complained of feeling ill and faint. A doctor was called, but Mr. Morse's condition became so serious that a private ambulance was summoned, in which he was taken to the Astor House. Oxygen was administered on the way to the hotel, and when he arrived the house physician was called in, but, in spite of the efforts of the physicians, Mr. Morse died soon after he reached the hotel.

Mr. Morse was born in Poland, Ohio, in 1850, his father coming from New England and his mother from Virginia. He graduated in 1871 from the Rensselaer Polytechnic Institute, Troy, N. Y., and entered the employ of the Pennsylvania Railroad as assistant engineer of the Allegheny Valley line. From 1873 to 1878 he was assistant engineer of the Wrought-Iron Bridge Company, and from the latter date to 1887 he was senior partner of the Morse Bridge Company, Youngstown, Ohio, contracting railway and highway bridges. He next became president of the Edgemoor Bridge Works, Wilmington, Del., which position he held until 1896, when he resigned to accept the presidency of the Harlan and Hollingsworth Company, of the same city.

Two years later Mr. Morse resigned from this company to undertake the designing, construction, and operation of the new shipbuilding plant which was later named the New York Shipbuilding Company and located at Camden, N. J. Twelve months were spent in preliminary work in developing designs, securing the necessary capital, and in seeking for a proper location, and in July, 1899, the actual construction of the plant began, and was carried on at such a rapid rate that in November, 1900, the keel of the first ship was laid.

Up to the time of his death, Mr. Morse had secured for his company twenty contracts, seven of which have since been completed and delivered, and one was ready for delivery at the time of his death. These ships range from 300 to 615 feet in length, consisting of cargo carriers, oil-tankers, freight and passenger steamers, and several classes of government work. Mr. Morse was a member of numerous engineering societies, among which were the American Society of Mechanical Engineers, American Society of Civil Engineers, American Institute of Mining Engineers, Society of Naval Architects and Marine Engineers, all of New York, N. Y.; the Institute of Naval Architects of London, Union League and University Club and Engineers' Club of New York, N. Y., and the Union League Club of Philadelphia. Mr. Morse leaves a widow, three sons, and three daughters.

Herewith are appended resolutions adopted by the Board of Trustees of the New York Shipbuilding Company at a special meeting held June 6:

Since the last meeting of this board a great misfortune has befallen this company in the death of our president, Henry G. Morse, which occurred in New York city, where he had gone in the performance of his duties as president, on Tuesday, June 2, 1903, at 3.30 P.M. The remarkable ability and the undoubted honesty and integrity of purpose which Mr. Morse had always displayed in the discharge of his duties as president of this company, and his faithfulness in its service, demand our warmest expressions of esteem and confidence; and true recognition of the value of his services, of his wonderful talent as an organizer, clearness of conception in inaugurating and carrying out to a successful termination the great plant which was the entire conception of his brain, and which will always stand a monument to his memory, demands our most sincere and unqualified recognition and our deepest regret and sorrow for his death.

HENRY G. MORSE.

He was a man of tireless energy, of kindly and engaging manner, and he had so endeared himself to the officers and employees of the New York Shipbuilding Company that he had created a harmony of feeling and a unity of action among them which will continue to be a marked advantage to this corporation.

Therefore be it resolved, That the directors of this company tender to Mrs. Morse and her family their assurance of profound sympathy with them in their great loss; and

Resolved, That a committee of three be appointed by the chairman of this meeting to procure a design for a bronze tablet to be erected in some advantageous position in the plant, upon which shall be placed a suitable inscription commemorative of Mr. Morse's great services to the corporation, and that such committee make a report at the next meeting of this board;

Resolved, That a copy of these resolutions be entered upon the minutes of this company and sent to the family of Mr. Morse.

Mr. De Courcey May, formerly general manager, has been elected president of the New York Shipbuilding Company.

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Lubrication.

Editor MARINE ENGINEERING:

I have read with much interest Mr. Nye's article in the June number of MARINE ENGINEERING dealing with methods of testing oils, and, being in the oil business myself, I would like to present the other side of the question.

No doubt there are many engineers who are fully competent to make such tests, and who are sufficiently unbiased and unprejudiced to reason with, but I must say that, judging from my experience, I believe that if you placed a set of oil-testing apparatus in the hands of all engineers, many of them would have some special requirements for a lubricant. Thus, one engineer will want such a flash point and such a viscosity, and no amount of argument can convince him that oils of any other tests are as good, while the second engineer may require what the first one would not use. Thus the number of grades of oils that the oil companies would have to supply would be almost unlimited.

It is impossible for every engineer to become an expert in the question of oils. Now, at our works we have experts whose special duty it is to make experiments constantly with different lubricants for different purposes, and from the results they obtain we prepare oils best adapted for each use. I claim that these experts know more about lubrication than it would be possible for engineers to learn, unless they devoted their entire time to the subject, which, of course, is impossible.

It is our desire to sell to the trade the very best oil obtainable, for many of our contracts are to supply enough oil to lubricate a certain factory, railroad system, or steamboat line, and the poorer the quality of oil the more oil must be supplied, and we find cheap oil is the most expensive. Therefore, I would suggest to the readers of Mr. Nye's article that, if they take up the matter of testing oils, they accept the opinions of experts as to what are the best oils for different requirements, for an oil that is good for one cylinder is surely good for a second cylinder, or an oil good for one journal bearing should be equally as well suited for a second journal. If the engineers will ask all the large oil companies what in their opinion are the best oils for certain purposes and what the tests for same are, and use these figures as standards, then the engineers can make their tests on other oils and accept none but those which come up to these requirements. The oil trade would be thrown into perfect chaos if each engineer should have his own ideas about the requirements of oils.

Again, Mr. Nye deals a pretty hard blow against the oil drummer, which, I think, is unjust, for my knowledge of these men is that they are a very respectable class of hard workers. J. W. M.

Knight Bachelor.

Editor MARINE ENGINEERING:

Referring to your article in the April issue on "Head-On Collision of the Steamer *Knight Bachelor*," would state that the collision happened several years ago, about four and a half days from Halifax, which port the ship made unaided in perfect safety. The ship was bound west, light in water ballast, to load cotton for Liverpool to Continental ports. In the collision the greater damage was done above her water line; and below, her plating and stem were buckled in such a manner as to form an excellent cofferdam to the pressure of the sea against the collision, the chain locker, and No. 1 bulkheads, which were not damaged to any great extent. The new frames, stem, etc., were bent by the builders, Messrs. Connell, of Glasgow, Scotland, and shipped to Halifax, where the work was completed. The bow had quite the appearance of the original, and spoke well of the workmanship and the small facilities at hand.

R. L. MUIR.

QUERIES AND ANSWERS.

Q. 153.—Will you please answer the following questions in your Queries and Answers column:

How will you determine the size, capacity, and I. H. P. of fan and its engine for the purpose of forced draft in boiler room and cabin ventilation? SUBSCRIBER IN JAPAN.

The subjects of ventilation and forced draft, although closely allied, are dealt with separately. Where mechanical draft is used it is necessary to know the details of the boilers and the amount of coal necessary to burn. In natural draft from 12 to 15 pounds of coal may be burned per square foot of grate surface, while under forced draft double this amount, or 20 to 35 pounds, may be burned per square foot of grate. Each pound of carbon requires about 12 of air for complete combustion, theoretically; in practice it is found that this figure rises to about 20 pounds. In practice a pound of coal is considered equivalent to a pound of carbon in heating value and in the air required. Let us assume a special case of four single-end, three-furnace Scotch boilers, the furnaces each having a grate surface of 23 1-3 square feet, or 280 square feet in all, and that it is necessary to burn 30 pounds of coal per square foot of grate. Then the pounds of air necessary to burn this coal will be:

$$20 \times 70 \times 30 = 4{,}200 \text{ per boiler;}$$
$$4{,}200 \times 4 = 16{,}800 \text{ for 4 boilers.}$$

If the air is supplied at 90 degrees temperature, 1 pound occupies 13.8 cubic feet, therefore 16,800 pounds at 90 degrees will be equivalent to 231,840, or about 230,000 cubic feet. This, then, is the air necessary for the fans to handle. At this rate of combustion, namely, 30 pounds per square foot of grate, an air pressure of about 2 1-2 inches at the fans will be necessary, and, on the authority of one of the fan makers, a 50-inch fan running at 800 revolutions per minute and requiring an engine of about 4 horse power will handle this air.

Regarding the second part of your question, it is generally considered that to change the air in the cabins six times an hour is sufficient. In some of the cabins it may be necessary to change oftener. The method of finding the capacity of fans for cabin ventilation, then, is, measure the space in each cabin in cubic feet, multiply it by the number of times the air is to be changed in that cabin, and add all such results for each cabin in which the ventilation system is to be fitted. This will give the cubic capacity of the fan. The pressure which the fan must maintain, whether an exhaust or forced-draft system, will depend on the length of ducts, the location of fan, etc.; but a pressure

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of 1 inch is in most cases considered sufficient. To fully understand mechanical draft one must study some of the text books on this subject, but the above examples cited show the outline of the two problems.

Q. 154.—Will you please answer the following question in your magazine:

Captain H. contends that a steamer running with the tide will log more knots than she will stemming the tide; I contend she will not, but will log the same. His idea is that running with the tide the wheel gets a better hold on the water. Which is right? E. L.

A.—Your stand in the question is right. The speed of a vessel should be measured by its speed through the water, and not by speed from points on land. There is no such thing as a propeller getting hold of the water better when going with the tide. As an illustration, take a steamer traveling in the ocean; would Capt. H. believe that the speed of a ship in reference to the water would be greater when going with an ocean current than it would when going against one? His idea is a mistaken one, and theory and practice fail to prove it. In official trials government vessels are run over the course in each direction, and the mean of the two speeds taken. If there were any such fact as Capt. H. claims, this would long ago have been discovered by the officials, who go into tidal corrections very minutely.

Q. 156.—What can I do to stop the noise of the checks on a feed pump which is connected to the rocker shaft of low-pressure engine and has 1 1-2-inch plunger and 10-inch stroke? Pipe is 1 1-2 inches to boiler. There is a check valve next to pump and one next to boiler, and both make too much noise. Would larger pipe and checks help? I have tried an air pass from pump to hot well of 1-4-inch pipe, but it is not a remedy. Would sharpening plunger do any good? Will you please give me a remedy? R. D. T.

A.—Your trouble is undoubtedly due in some measure to the small size of pipe in comparison with the plunger. The hammering of a check valve depends to a large extent on the velocity of the water through the pipe. The greater the velocity the more violent the shock at starting and stopping, and the greater the noise. It would certainly help matters to put in a larger pipe and checks. You make no mention of an air chamber on the discharge side of the pump. Such a chamber of ample size has a great influence in reducing shock and noise, and in maintaining a nearly continuous discharge through the feed pipe. Between these two methods you should be able to improve matters satisfactorily.

Bids for Warships.

Bids for the three new 16,000-ton battleships were awarded June 9 to the three lowest bidders, as follows:

The *Vermont* to the Fore River Ship and Engine Building Company, Quincy, Mass., for $4,165,000.

The *Minnesota* to the Newport News Shipbuilding Company, Newport News, Va., $4,110,000.

The *Kansas* to the New York Shipbuilding Company, Camden, N. J., $4,170,000.

Contract for building one of the two new gunboats was awarded to the Gas Engine and Power Company, Morris Heights, New York, and the department has re-advertised for bids on the other vessel. It will be remembered that these gunboats will measure 174 feet on load water line and 35 feet extreme breadth, with a displacement of 1,085 tons; and their armament will consist of six 4-inch, four 6-pounders, and two 1-pounder rapid-fire guns, and two Colt automatic guns.

PERSONALS.

Edwin B. Sadtler, former chief hull draftsman at the William R. Trigg Company, is now naval architect at the Harlan and Hollingsworth Company. Before going to Richmond Mr. Sadtler for many years was connected with the Wilmington shipyard.

Louis H. Kenney, formerly with the Fore River Ship and Engine Building Company, is now assistant draftsman in the office of naval inspector of machinery, William Cramp and Sons Ship and Engine Building Company.

Walter E. Joynes, formerly draftsman with the Newport News Shipbuilding and Dry-Dock Company, has accepted a position in the hull-drawing office of the Bath Iron Works.

E. S. Cooley, formerly with the Newport News Shipbuilding and Dry-Dock Company, and lately an instructor in Sibley College, has just accepted a position with the Buffalo Forge Company as inspecting engineer.

Alfred B. Canaga, superintendent of machinery for U. S. S. *Connecticut*, Navy Yard, New York, N. Y., is now in charge of the designing and drafting in the Bureau of Steam Engineering, Navy Department, Washington, D. C.

William J. Norton, who was formerly with the Manitowoc Dry-Dock Company, Manitowoc, Wis., as general draftsman, has taken a position in the hull-drafting department of the New York Shipbuilding Company.

William Burlingham has accepted an appointment as chief engine designer with the B. F. Sturtevant Company, of Hyde Park, Mass., resigning a position in the United States Inspection Office with the William R. Trigg Company, of Richmond, Va. Mr. Burlingham has previously been associated with the Bath Iron Works, the General Electric Company, the Southwark Machine and Foundry Company, and the Newport News Shipbuilding and Dry-Dock Company.

LAUNCHES.

H. M. S. Battleship Commonwealth.—The largest battleship afloat was launched on May 13 from the yards of the Fairfield Shipbuilding and Engineering Company, Ltd., Govan, Glasgow, Scotland. She has a draft of 26 feet 9 inches and the displacement will be 16,350 tons, while the launching weight was about 8,000 tons. The principal dimensions are: Length between perpendiculars, 425 feet; breadth, 78 feet; depth, 26 feet 9 inches. Krupp armor is used, and the side belt is about 22 feet deep, varying in thickness from 9 inches above the water line to 7 inches at the upper deck amidships, and 3 inches forward and 2 inches at the after end. The armament consists of four 12-inch guns mounted in pairs in barbettes forward and aft, and four 9.2-inch guns in barbettes, one at each corner of the central citadel. There are also ten 6-inch guns, fourteen 12-pounders, fourteen 3-pounders, two machine guns, and four torpedo tubes. The propelling machinery consists of two sets of four-cylinder, triple-expansion engines, the diameters of the cylinders being 33 1-2, 54 1-2, 63, and 63 inches, all built for a stroke of 4 feet. The low-pressure cylinders are fitted with double-ported slide valves, and the high- and intermediate-pressure

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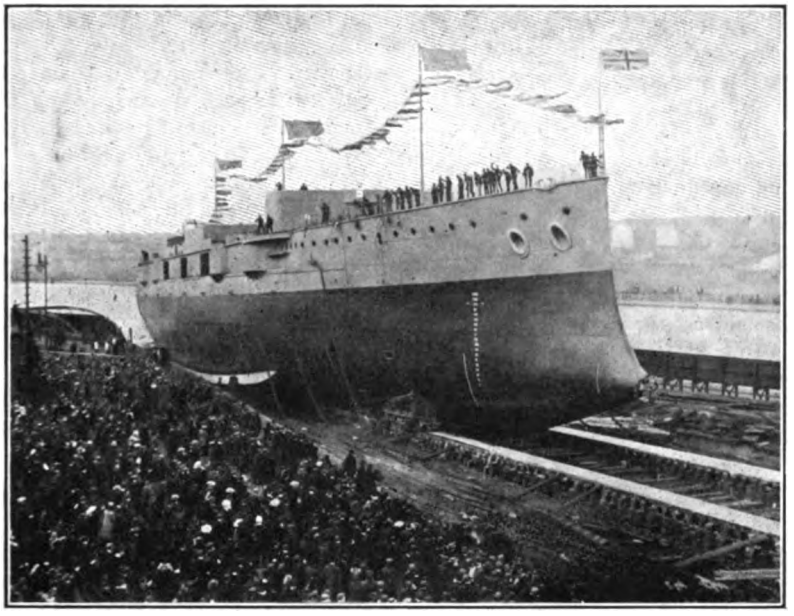
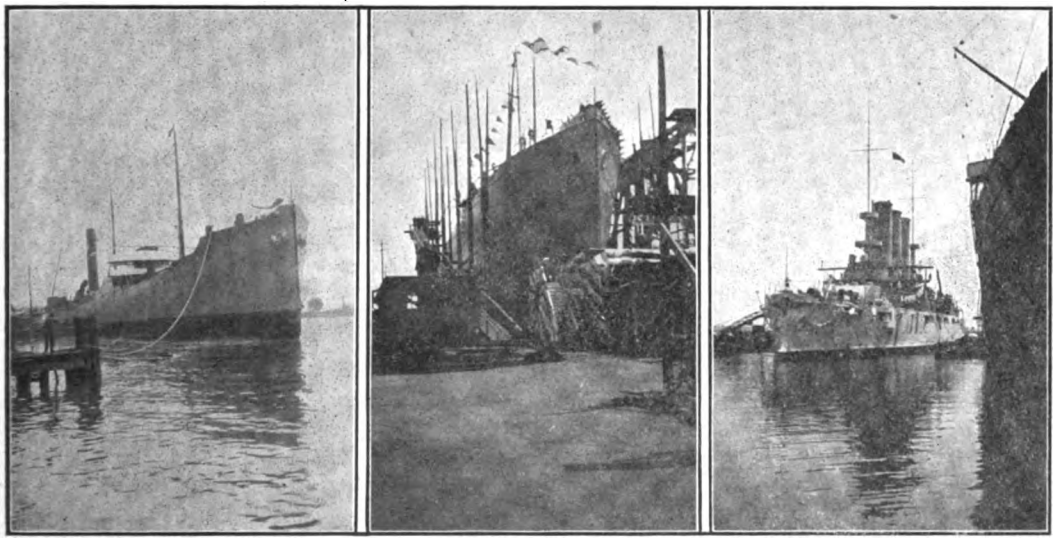
with piston valves; machinery to develop 18,000 I. H. P. and to give a speed of 18 1-2 knots. It is of special interest to note that the sixteen boilers, designed to work at 270 pounds pressure, are of the Babcock and Wilcox type. They are arranged in three water-tight compartments; the necessary air will be supplied by large steam-driven fans.



LAUNCH OF THE BRITISH BATTLESHIP COMMONWEALTH FROM THE FAIRFIELD YARD, SCOTLAND.
[Photograph copyrighted, 1903, by McLeherson, Glasgow.]

Steam Yacht Carmina.—The steam yacht *Carmina* was launched successfully at Lawley's yard, Boston, Mass., on May 2, 1903. The *Carmina* is the largest steam yacht ever built at this yard. She is built of steel, the plating being on the raised-and-sunken system. The principal dimensions of the *Carmina* are: Length over all, 170 feet; on water line, 139 feet 9 inches; beam, 22 feet; draft, 10 feet 6 inches. There are two water-tube boilers of 250 pounds each, and she is propelled by a four-cylinder, triple-expansion engine of about 1,400 horse power driving a single screw. The *Carmina* was built under special survey of Lloyd's and is expected to be rated A 1.



The Oil Tanker Capt. E. F. Drake. *The Steamer Kiowa.* *Battleship Maine.*

VIEWS OF NEW SHIPS AT CRAMPS' SHIPYARD.

Five-Masted Schooner Dorothy Palmer.—The finely-modeled five-masted wooden schooner the *Dorothy Palmer* was recently launched from the yard of George L. Weldt, Waldoboro, Me. She is 273 feet keel, 46 feet 6 inches beam, 26 feet 6 inches depth of hold, and the registered tonnage 3,000 gross tons. The ship is built of very heavy oak framing, hard pine planking, and the very strongest fastenings. The five lower masts are each 118 feet long and of Oregon pine, while the top-masts are of spruce 60 feet long. The total spread of sail will be 12,000 yards. A steam boiler is used for running all auxiliaries, including windlass, steam steering gear, pumps, electric lighting set, etc.

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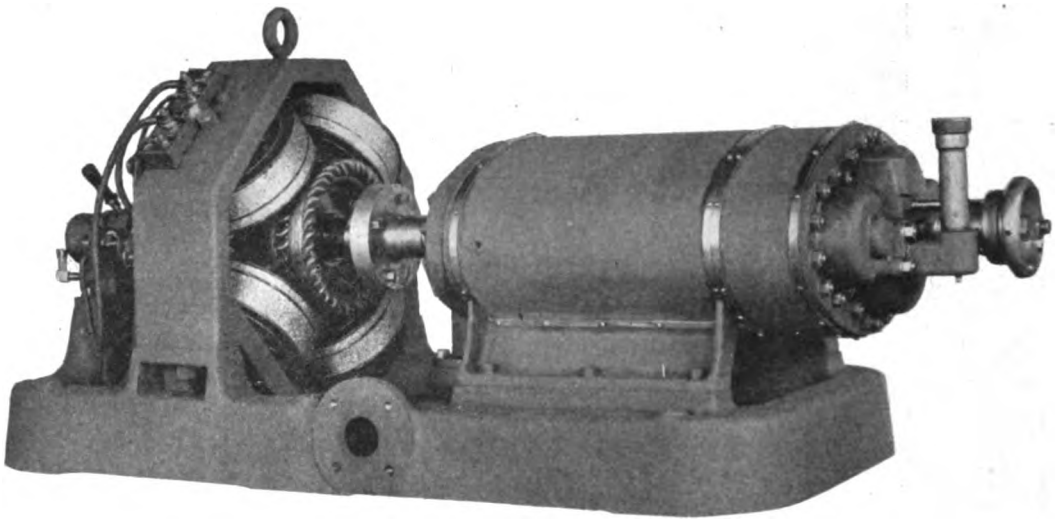
The Warren Rotary Engine.

It is odd to note that in the development of the steam engine the form first brought out by Hero, in Alexander, in the year 120 B.C., has for centuries been neglected, engineers and inventors confining their work to the reciprocating engine as brought out by James Watt. The latest developments of steam engineering are along the lines of the original Hero engine, a reciprocating or turbine type.

The turbine has established a place for itself in steam engineering, regardless of its inherent disadvantages of high speed. So many inventions of rotary engines have been brought out and failed that the term now often is considered equivalent to that of perpetual motion. The problems involved were most difficult of solution, and consisted in securing adequate and properly disposed ports, cylinder ratios and clearances, perfect balancing, and, above all, in securing steam-tight joints at a piston speed so high as to prohibit the use of any heretofore known means of packing.



ROTARY ENGINE, DIRECT-CONNECTED, 14-K. W. SET. DESIGNED FOR 80 POUNDS OF STEAM. COMPOUND, NON-CONDENSING.

As the result of many years of study, experiment, and investigating the patents of rotary engines, it was evident to the designers of the Warren engine that the fundamental difficulty to be overcome was the question of tight joints at the desired piston speed of 3,000 feet per minute, which speed was considered most desirable and economical for this type of engine. This principle, so important for this class of engine, proved to be remarkably simple. Eliminating friction and securing perfect mechanical contact between two surfaces, without subjecting these surfaces to unnecessary and injurious pressure, in order to hold them together against the action of steam, is briefly what has been accomplished in this engine. In a word, perfect contact is maintained without appreciable pressure between the sliding surfaces. Therefore, as the elements that contribute to the production of mechanical friction are simply surface area multiplied by the pressure, if the pressure element be eliminated there cannot be any friction between the surfaces, regardless of their relative speed. Two highly-polished surfaces may be placed in intimate contact without the use of any measurable pressure, and such a contact will be as steam-tight as if the surfaces were forced together under heavy pressure.

Now, considering the accompanying drawings from the Rotary Engine Company of Philadelphia, we can follow the method of working out this principle. On this page is given a photograph of a direct-connected generating set, with rotary engine, and of about 14 K. W. capacity. The engine is a compound, designed for special service with steam only at 80 pounds, and is non-condensing, which, as stated by the builders, makes it abnormally large in proportion to generator.

Figs. 1 and 2 show the longitudinal and transverse sections through the engine, which consist essentially of a concentric piston wheel, *A*, and shaft, mounted between two oppositely placed rotary abutments, *B, B*, said abutments being driven by the gear, as shown at the right in Fig. 3. The piston wheel *A* carries a broad flange at either end, between which, across the face of the drum of the wheel, the vanes or pistons, *C, C*, are mounted, the outer edge of the blade being turned off in line with peripheral surface of the flanges. The wheel *A* fits into the cast-iron casing, so that there is practically no clearance between the surface of wheel and casing. The heads of the casing fit into the ends of the driving wheel and form the ports *P*; thus the inside of the wheel is in close contact with the heads of the inner casing. The main bore of casing and wheel has a slight taper from end to end, and the wear is taken up at the thrust bearing, the thrust being due to the slightly different diameters of the two ends of the tapered wheel exposed to the steam pressure; thus the moving surfaces are maintained in pressureless contact. The wear of the surfaces is designed to equal the wear in the thrust bearing, so that the wheel will work gradually into the taper to make up for the wear of blades on the casing. The thrust is also adjustable, and thus an intimate contact is secured. This has been demonstrated from an engine of this kind run at speeds up to 5,000 feet per minute, when the contact surfaces were brought to a mirror-like polish. Thus, a nice mechanical balance is maintained in this ideal condition of contact without meeting with the extreme difficulties

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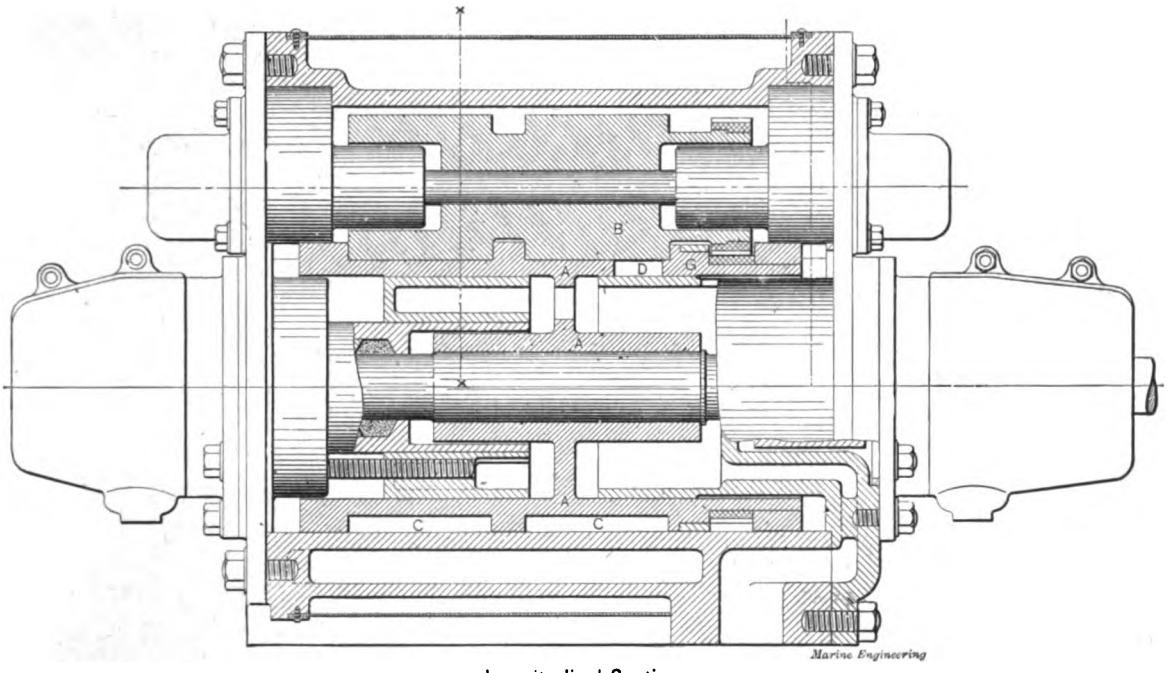
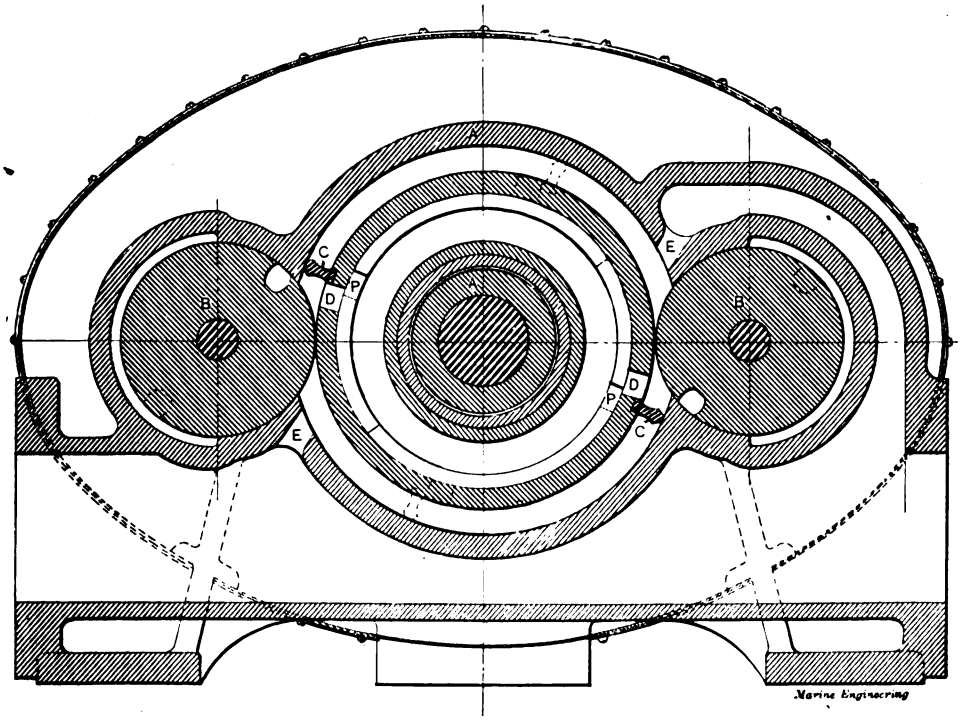
encountered in balancing turbine wheels running at five to seven times the peripheral speed. It will likewise be noted that the lateral pressures upon the wheel and shaft are perfectly balanced, since equal areas at diametrically opposite points are exposed to equal pressures. Thus the driving wheel is free from all strains tending to deflect it from its center and axis of rotation other than its own weight, which is taken care of by large, well-lubricated journals.

In the abutments *B, B* it will be seen that there are grooves extending from end to end for admitting vanes *C, C*, and for ample clearance. The abutments are driven by a gearing giving a ratio of two to one, the single groove in the abutment being thus made to meet



Longitudinal Section



Cross Section at XX

FIGS. 1 AND 2.—LONGITUDINAL AND CROSS-SECTIONAL VIEWS OF THE WARREN ROTARY ENGINE.

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successively each piston. The abutments are mounted on shafts having bearings formed in the counterbored end plates of the abutment chamber. Provision is made in these bearings for applying pressure to more than counterbalance the pressure of the steam tending to force abutments and piston wheel apart and to open up the joints. This pressure varies with the working steam pressure. It will be noted that the pitch diameter of the gear, Fig. 3, is slightly less than the outside diameter of the wheel; therefore there will be a sliding contact between abutment and wheel, which will cause the two rolling surfaces to wear each other away. This difference in speed amounts to about 600 feet per minute. Similarly, the seats formed by the bore of the abutments will be worn away at an exceedingly slow rate. As the wheel progresses slightly into its bore the abutment can follow it closely, as it is free within certain limits to follow the longitudinal movement of the wheel.

Now, referring to the operation of the engine, it may be stated that the steam cycle is essentially similar to that of a Corliss engine, except that the admission and cut-off are equally quick. Steam is admitted into the interior of the drum-shaped piston wheel, as shown in Fig. 3, and enters the working steam chambers through ports *D* and *D* in the drum of the wheel; the engine shown being of the type designated as duplex simple, that is, the single-expansion chamber is divided by an intermediate flange into two equal compartments, having pistons set 90 degrees apart in order to insure uniform turning moment. The two drum valves, *P*, *P*, are mounted upon inwardly-projecting hubs cast as an extension of the casing heads, and, in the simple form of engine shown, are made fast to these hubs, giving a fixed cut-off; governing, when required, being accomplished by throttling. In the larger sizes and in compounds the drum valves are arranged to be shifted upon the hubs, and are controlled by a special governor, which regulates the speed of the engine by varying the point of cut-off in the high-pressure cylinder.

It is not necessary to maintain a perfectly tight joint between the drum valve and the interior surface of the piston wheel, as any leakage past the valve merely results in raising the expansion line in the working chamber and adding a slight superheat during the latter stages of expansion. The valve is, therefore, fitted simply with a close "running fit." The lowering of the main wheel through wear cannot proceed far before the increase of mean pressure in the lower steam chamber will become sufficient, acting upon the full projected area of the wheel drum, to balance or support the weight of the wheel and shaft, and it is obvious that after this point is reached there can be no further downward wear of the main journals, and, consequently, no further increase of leakage past the cut-off valve. When the port *D* has passed the opening of the valve, steam is cut off and expansion takes place until the blade reaches the exhaust port *E*, when the steam exhausts into the passages shown. No tests of steam consumption are as yet given out. It is claimed that a saving of 10 per cent. may be secured over reciprocating engines because of the absence of frictional resistance. Having in view the continuous turning effort, absence of reciprocating parts, the features of the cut-off, expansion, and exhaust, there ought to be realized high economy in large sizes.

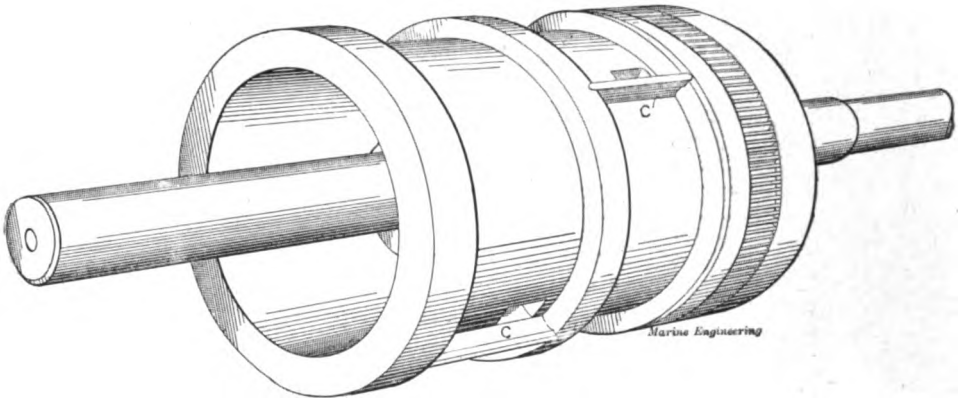

FIG. 3.—PERSPECTIVE VIEW OF THE RUNNER, OR ROTATING MEMBER.

As the Warren engine is readily reversible, possessing the desirable qualities of the steam turbine while rotating at lower speed, it ought to be peculiarly adapted for marine propulsion. The other features which are claimed to adapt it to general steam-engine service are that it has all the desirable features of the reciprocating engine, has practically unlimited range of speed with uniform angular velocity, is free from vibration, is of greatly reduced bulk and weight, and is sold for less than either reciprocating engine or turbine.

Revoke Engineer's License.—The local board of the United States Steamboat Inspectors of the port of New York rendered a decision recently revoking the license of Joseph W. Cornell, a tugboat engineer, who, previous to the recent strike, was employed by the Newtown Creek Towing Company Charges against him were preferred about two weeks ago by the company formerly employing him. It was alleged that Cornell quitted his employment without giving sufficient reasons, and thereby violated the oath under which he held his license. Charges were brought by the Newtown Creek Towing Company and by the White Star Towing Company against other engineers in their employ. The action of the local board in this case will stand unless an appeal is taken to the Supervising Inspector, as under law an engineer has thirty days in which to appeal.

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The Sirocco Fan.

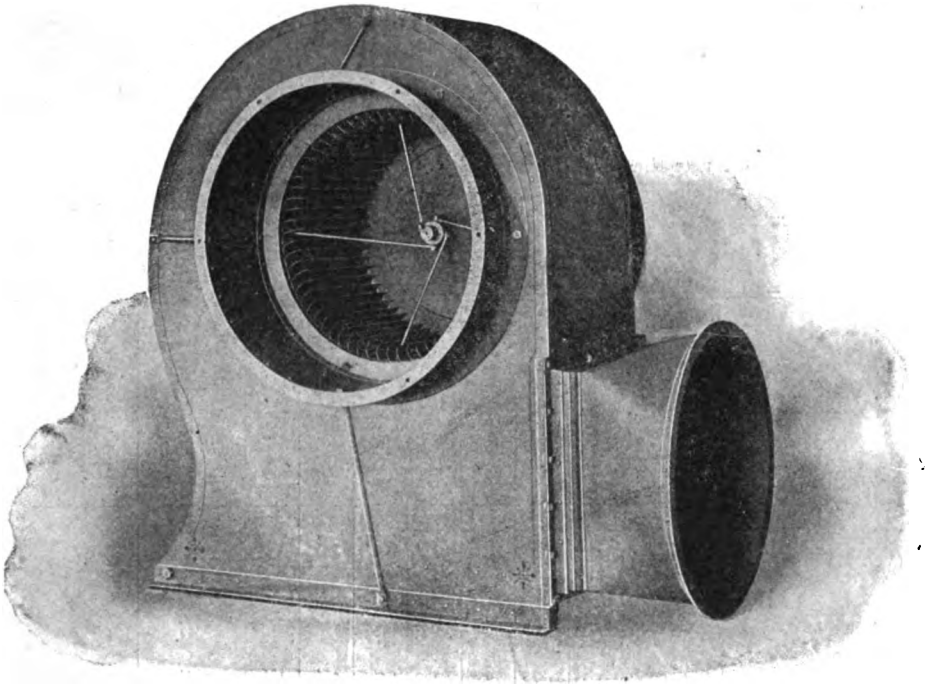
A most interesting exhibit of a new type of fan, called the Sirocco Centrifugal Fan, is now to be seen in New York city. The fan is built differently from other centrifugal fans, in that the blades are long, narrow, and curved forward in the direction of rotation and mounted parallel to the shaft. The length of the blades is three-fifths of the diameter, and it has been found that over the several sizes of fans sixty-four blades give the best results. The blades are riveted to an iron ring at the back, which is attached to a cast-iron conical hub, and the front ends of the blades are riveted to an iron ring adjustable by guy rods, as shown in the illustration. The blades measure radially one-sixteenth the diameter of the fan and measure lengthwise three-fifths the diameter. The inlet of the fan is through the area inscribed by the forward ring, and the discharge is through a casing, as is usual in centrifugal fans. The inlet and discharge areas are practically the same.

With the fan thus briefly described, some very interesting experiments were performed to compare it with the ordinary type of centrifugal fan. It is claimed by the makers of the Sirocco that the use of this fan shows an entirely new departure from the former science and principles of centrifugal fans, and that if the old rules for volumetric efficiency were applied to this type the result would work out to something like 400 per cent.

The exhibit consists of several Sirocco fans, each mounted to illustrate a different feature. One is of a 25-inch motor-driven fan running at 550 revolutions, or with a peripheral speed of 3,600 feet per minute, discharging air at a velocity, according to measurements, of 6,000 feet per minute, and representing a discharge of 16,000 cubic feet at zero pressure. Next was a fan of 17 1-2 inches in diameter, with hand gearing, discharging into a box with adjustable openings and fitted with pressure gage. The fact that the power required to drive a fan increases as the area of the discharge is increased, up to a certain area, is one that is seldom realized. The observer of this exhibit need but turn the hand gear of this fan and feel the increased load as the discharge area is opened, to fully realize that the load increases with the area of discharge.

The most interesting exhibit in the room is that called the "tug-of-war" contest, which consists of two fans, one a 12 1-2 inch Sirocco and the other a 24 3-4-inch centrifugal blade fan of the ordinary type. The discharge from each of these is led directly into a sheet-metal air-tight box, one discharge entering the box at one end and the second discharge at the other end; the box is divided by a division wall, with a door in same. Both fans are belted from a line shaft, the pulley being of such diameter that the Sirocco fan makes higher number of revolutions but a slightly decreased peripheral speed than the ordinary fan. The area of discharge of each fan is the same, and, according to the accepted rules, the pressure against which air is discharged should be practically the same, as the peripheral speed of the blades is the same. It is claimed, however, that the air leaves the Sirocco blades at a greatly accelerated speed, and that it actually exceeds the peripheral speed by about 70 per cent., as shown in the test of the 25-inch fan, above mentioned. This increase is claimed to be due to the curvature of the blades and to the fact that there are no eddies or back currents of the air in passing through the blades.

A test of these two fans was run by our representative, and the results are given in the appended table. When



INTAKE VIEW SHOWING RUNNER OF SIROCCO FAN.

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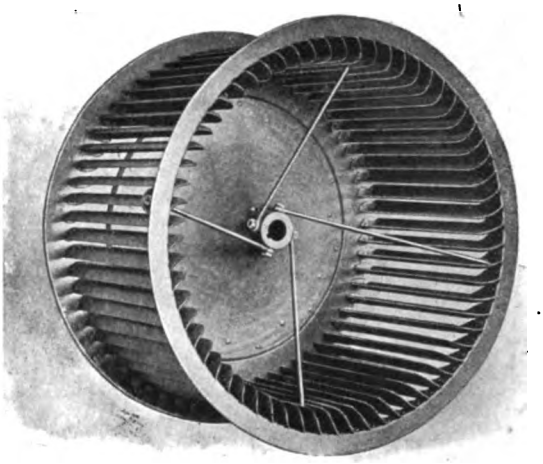
the two fans were running at a peripheral speed of about 4,000 feet per minute for the Sirocco and 4,200 of the ordinary fan, discharging into the closed box with the door in division wall open, a most remarkable result occurred. A little red flag placed in the opening showed clearly that the draft was going from the Sirocco to the other fan, and at no uncertain speed. This fact was further demonstrated by the draft of air at the suction of the Sirocco, which was most decidedly inward, and at the suction of the other fan, which was to the same extent outward. A large door in the top of the box was quickly opened and closed, and every time that it was closed the same direction of the draft was observed.

The second part of this test consisted in closing the division door and measuring the discharge through the door in the top of the box. Each discharge was of exactly the same area, viz.: 8 5-8 by 12 3-8 inches. The air pressure in the Sirocco box was 1 5-8 inches and in the other box 1 inch. The third test consisted in closing the upper door, with the division door also closed. The pressure in the Sirocco box was then 2 5-8 inches, while in the other box it was 1 3-8 inches.

The volt and ammeter readings of the dynamo which was driving the line shaft were taken under each of the conditions and will be found in the record of the test.

There was no way of measuring exactly the power required to drive each fan, but comparative values were obtained, first, by taking the belt off the Sirocco fan and running the ordinary fan, and then by replacing the Sirocco belt and removing the other belt. The results will be found under the table of the fourth test. It must be remembered in this connection that the volumetric discharge of the Sirocco, as recorded, was much greater than that of the other fan. It is claimed by the makers that the mechanical efficiency of the Sirocco is about 10 per cent. greater than that of other fans, and this statement has been carefully checked by test No. 5.



THE RUNNER.

COMPARATIVE TESTS OF SIROCCO AND ORDINARY-TYPE FAN.

Tests.	Rev. per Min.		Peripheral Speed. Ft. per Min		Air Pressure. Inches.		Amperes.		Volts.	
	Sirocco.	Ordinary.	Sirocco.	Ordinary.	Sirocco.	Ordinary.	Sirocco.	Ordinary.	Sirocco.	Ordinary.
No. 1. Box closed, division door open..... (Vel. air into Sirocco over area of 154 sq. ins. = 3 000 ft.)	1,250	690	4,110	4,470	2	1	20		107	
No. 2. Box open, division door closed.....	1,235	680	4,050	4,400	1⅝	1	23½		107	
No. 3. Box closed, division door closed.....	1,275	705	4,180	4,565	2⅝	1⅜	18¼		108	
No. 4. Each fan run separately. Box open, door closed.....	1,285	720	4,220	4,660	1⅝	1⅛	21½	15	108	108⅜
Zero load of shaft, etc..	..	..	..	..	..	..	8		109	

Test No. 5.	Rev. per Min.	Peripheral Speed. Ft. per Min.	Air Pressure. Inches.	Vel. Air at Discharge.	Cu. Ft. Air per Min.	Amperes	Volts.	Watts.
Sirocco.....	1,000	2,280	1	4,000	35,500	16	86	1,375
" zero load.....	..	..	..	..	..	7	98	686
" power absorbed by fan	..	..	..	..	..	..	..	689
Ordinary.....	710	4,600	1	3,960	35,200	15	111	1,665
" zero load	..	..	..	..	..	8	112	896
" power absorbed	..	..	..	..	..	..	..	769

The same instruments, voltmeter, ammeter, and anemometer, were used for all tests. They were not calibrated, as *comparative* results alone were desired.

To demonstrate that a fluid in passing through a Sirocco fan is given a higher speed than the tips of the blades, the fourth exhibit was most interesting. As it is almost impossible to measure absolutely the velocity of air, this point is demonstrated by using a 6-inch Sirocco fan as a water pump. The suction of the fan is connected with a large tank and the discharge takes place

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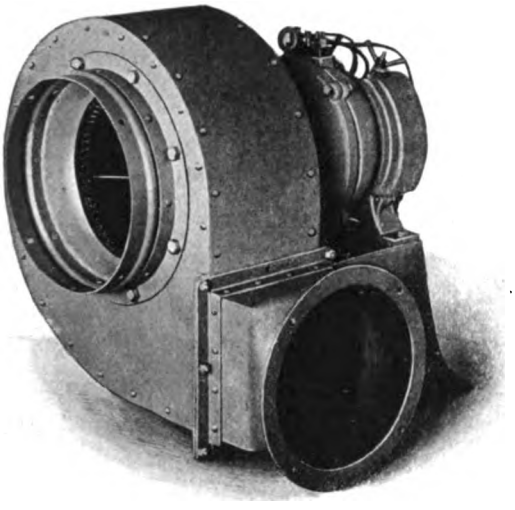
at a level just 4 feet above the suction level when the pump is running. A 4-inch discharge pipe is used. The runner is geared to a hand wheel at the ratio of 8.3 to 1;

TABLE OF DIMENSIONS.

	Sirocco.	Ordinary Type.
Runner, diam. over all ins.....	12½	24¼
" length of blade	7¾	7¾
Casing, width, ins.....	11	12
" " over all, ins.....	15	16¼
" length " " "	25	37½
" height above floor, ins.....	31¼	42
Inlet, area, sq. ins.....	95*	154
Discharge from box, sq ins.....	106.6 8½x12⅔	106.6

*At point where velocity of air for Test No. 1 was taken the area of inlet is 154 sq. ins.

on turning this hand wheel 60 revolutions per minute a solid column of water was discharged through the pipe at the above-stated level. At this number of revolutions the peripheral speed of the blades is evidently



SMALL MOTOR-DRIVEN FAN. CASING CAN BE ADJUSTED TO DISCHARGE IN ANY DIRECTION.

$60 \times 8.3 \times 1.57 \div 60 = 13$ feet per second, while by formula the theoretical velocity required to raise water this height would be 16 feet and the residual velocity of discharge being about 4 feet, with a frictional resistance in the pipe of about 1 foot per second. Thus this pump has to work against an equivalent head of 21 feet, while the velocity of the blades is but 13 feet.

Still another test (No. 5) was made to ascertain the comparative amounts of power required to drive the two competitive fans while discharging the same output against the same pressures. Each fan was driven singly by the motor, the speed of the Sirocco being regulated down by means of the rheostat on the dynamo till the pressure in the box equaled that of the other fan. This was checked by anemometer readings of the discharge, the discharge from box of each fan being of the same area.

Another interesting feature of the exhibit is a type of propeller fan, which is put together and mounted in a very strong but simple manner.

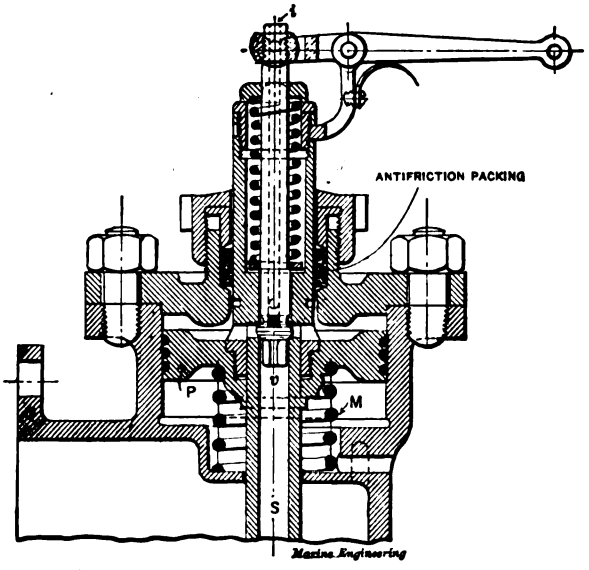
These fans may be seen in operation and the above experiments observed at the office of Davidson and Company, Ltd., 22 Thames street, New York city.

ENGINEERING SPECIALTIES.

New Form of Safety Valve.

The description of the Tippett safety valve which appeared in the November, 1902, MARINE ENGINEERING, has elicited from Mr. Dagnino Attilio, Sampierdareno, Genoa, Italy, a description of a similar safety valve invented and patented by himself, the operating mechanism of which is herewith illustrated.

The main valve is mounted on a spindle, *S*, and is controlled by the small valve *v*. When the steam pressure reaches the point at which the valve is to blow off it raises the controlling valve *v*, which is otherwise held in place by the light spring above it or by weights. The spring can be adjusted to any pressure. Steam escapes through the valve *v* behind the large piston *P*,



SIMPLE FORM OF SAFETY VALVE.

and forces this piston down against the spring *M*, opening the main valve, which is, as stated, at the other end of the spindle *S*. The main valve opens with promptness, but slowly until it has reached its full opening. When the boiler pressure decreases, the controlling valve *v* is closed, and the steam escaping through the ports, *i*, in the hollow rod, reduces the pressure behind the piston, *P*, and the valve closes. The points claimed for this valve are its simple construction and operation and that it is closed when there is no pressure in the boiler.

Feed-Water Heater.

It is a most essential thing that the feed water shall enter the boiler as warm as possible, both to effect economy of fuel and avoid wear of the boiler. In the consumption of fuel the average ship fitted with a triple-expansion engine uses 1.80 to 2 pounds of coal per indicated horse power per hour, but there are triple-expansion engines in use where the consumption of fuel is reduced to as low as 1.5 pounds per horse power per hour, and even about 1 pound in rare cases. This gain in efficiency is accomplished by having well-designed engines and boilers, and by the heating of the air furnished to the furnaces for combustion, the stoppage of

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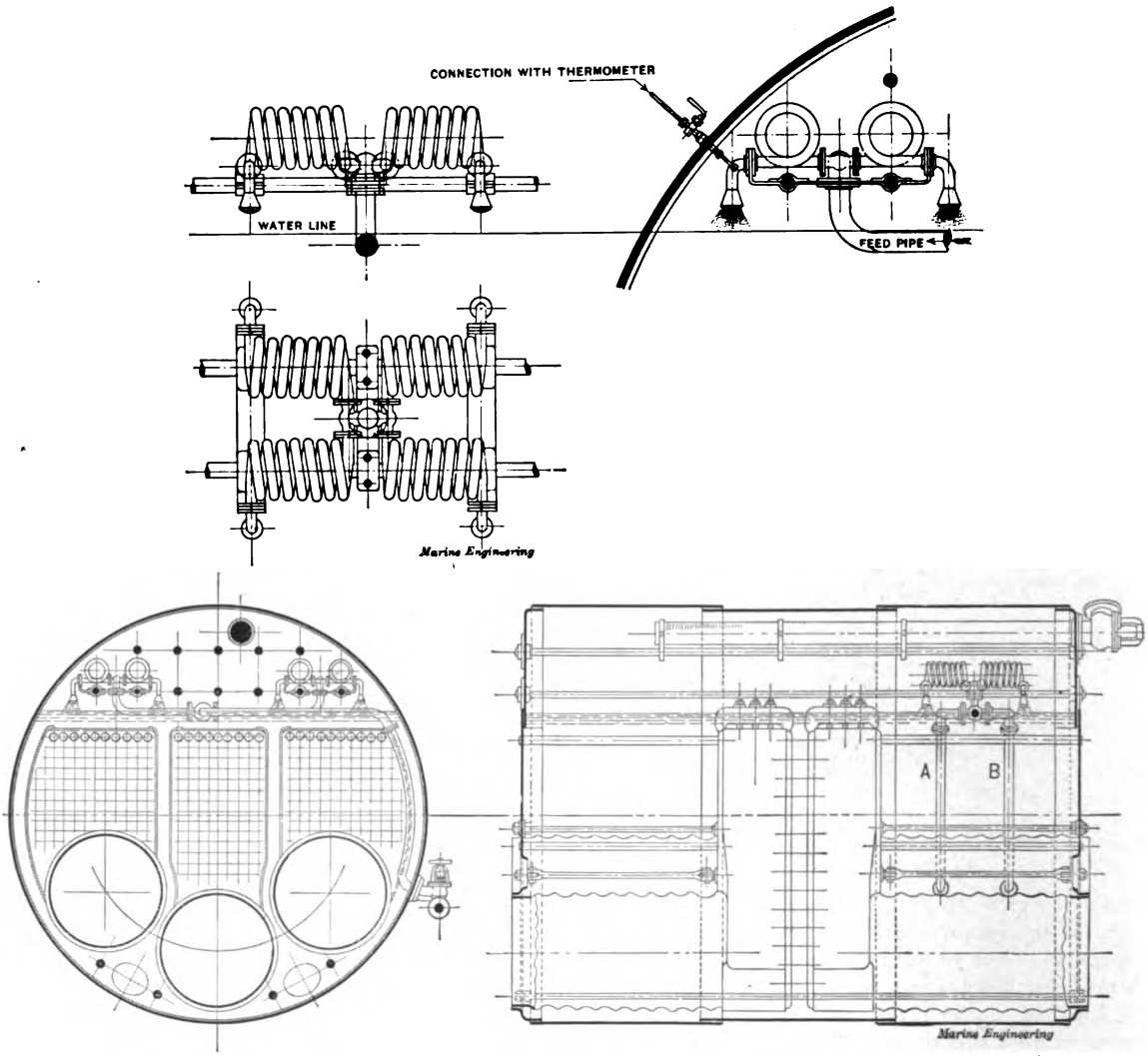
all steam leaks in boilers, pipes, engines, and stuffing boxes, etc.; but perhaps the most important item is the heating of the feed water. It has been estimated, for instance, that on a ship where the feed water is pumped into the boilers at a temperature of, say, 100 degrees, if a heater is fitted which, without entailing the use of heat otherwise useful, raises the temperature of the feed water to 212 degrees, a net saving of nearly 10 per cent. in the fuel will be accomplished.

by means of the tube *AB* with the feed-water valves, which are placed outside of the boiler. The feed water, passing through this instrument, becomes heated to a temperature which in no case is less than 60 degrees below the steam boiler temperature; hence, for a boiler working at steam pressure of 150 pounds, with the temperature of steam being 365 degrees, we get a feed-water temperature of 340 to 350 degrees. This apparatus does not occupy space in the engine room, requires



A TYPE OF FEED-WATER HEATER FOR USE INSIDE OF BOILERS.

Many attempts have been made to heat the feed water with exhaust steam, hot gases in the uptake, etc., but no great measure of success has attended the efforts of those who have paid most attention to this, for the apparatus employed has generally been insufficient, and, while costly and cumbersome, its durability has been short. The heater illustrated herewith is a very practical and a much cheaper instrument for the purpose, and its utility has been demonstrated by many applications on board modern and old ships of the Italian merchant marine. It has been designed and patented by Mr. Pautrie, of Genoa, and consists of four yellow copper coils, placed as is seen on the accompanying figure, in the steam space of the boiler and connected

but occasional cleaning, and it is always working, whether the feed water is injected by the main or auxiliary pumps.

Thus the feed water being discharged at the water level does not cause cold currents in the mass of water; the air that is always present in the water, being heated to a high temperature, goes off the boiler as gas, together with the steam; and the impurities and greases usually accompanying feed water do not come in contact with the heating surface of the boiler, but remain, instead, on the water level, and, therefore, being easily removable, prevent the acids produced by the fatty matter from causing injury to the iron surfaces. Further, feeding water at such high temperature, evaporation

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proceeds with greater rapidity, and constant pressure is maintained, while economy in fuel is good. The boilers of the new Argentine Republic battleship are fitted with Pautrie's heater.

In the month of July, last year, the bark *Ella Moore*, laden with railroad ties, ran ashore near Canso, Nova Scotia, about 200 miles from Halifax. The photograph shows how the vessel lay, almost completely

THE ELLA MOORE HARD AND FAST ON THE NOVA SCOTIA SHORE.

Wreck of the Ella Moore.

The shores of Nova Scotia are, during the summer months, veiled in heavy fog for more than half the time, and the rock-bound coast is strewn with wrecks. The force with which steam vessels here go ashore, and the nature of the coast, have prevented salving of but a small percentage of them.

land-locked, but fortunately she did not strike hard and was eventually saved. The illustration is remarkable for showing, first, that a vessel could float after striking head-on on such rocks as are in evidence; and, second, the depth of the water directly off the headlands of the coast.

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TECHNICAL PUBLICATIONS.

The American Steel Worker. By E. R. Markham. Size 5 1-2 by 8 inches. Pp. 343, with 160 cuts in the text. New York: The Derry-Collard Company. Price $2.50

This book is prepared by one who has had twenty-five years' experience in the selection, annealing, working, hardening, and tempering of various kinds and grades of steel. It is written from the practical rather than from the theoretical or scientific standpoint, and is intended primarily for the every-day use of the practical steel worker. To this end the author discusses the characteristics of the various grades of steel, and shows the relation of each to the composition and to the various operations to which the tool may have been subjected in the process of making. Useful hints are given regarding the selection of steels for various purposes, and the best modes of operation are given in detail for the various tools and special purposes to which tool steel may be applied. Beginning with the initial selection of a suitable grade of steel, the author discusses the best modes of heating, forging, annealing, tempering, and hardening steel tools, according to the purpose in view. Naturally the subject of tempering and hardening comes in for special notice, and illustrations are given of a great variety of furnaces, baths, vats, and other appliances for use in connection with such operations. Case-hardening by various processes is also fully discussed, and illustrated with cuts of the appliances and methods available for particular purposes.

As a whole, the book is clearly written, and gives to the point the information most likely to be needed by the practical worker in steel. One might have wished, perhaps, for a somewhat fuller treatment of modern special air-hardening steels for rapid work, as lathe and planer tools, etc. As the author properly notes, however, it is difficult to give general instructions for working such steels, because the composition and best mode of treatment of the different makes vary so widely that the treatment suitable in one case would be quite unsuitable in another. A few general hints are, however, given, which, with the special instructions accompanying such steels, should insure the best results of which the material is capable.

Modern competition in all classes of manufacturing work calls for the very closest attention to economy of production, and it is here that the importance of the steel tool enters the problem. The difference between a steel tool which will hold its edge and one which will not, between a tool which is producing the maximum output and one which is not, may make just the difference between success and failure or between profit and loss. An intelligent study of the directions and principles given in this book should go far toward insuring a possibility of the maximum output, so far, at least, as such may depend on the efficiency of the steel-cutting tools which may be employed. The book is cordially recommended to all steel workers, and to all interested in the treatment of tool steel for maximum productive capacity.

Bemastung und Takelung der Schiffe (Masting and Rigging of Ships). By F. L. Middendorf. Size 7 1-2 by 10 1-2 inches. Pp. 400, with 172 figures in the text and folding plates. Berlin: Julius Springer, 1903. Price 30 marks.

This work by the director of the German Lloyd was undertaken with the purpose of bringing down to date, in the literature of marine construction, many recent improvements and advances in this particular part of the field, a part which has suffered some neglect since the passing of the sailing ship as the embodiment of the best art and skill of the naval architect and shipbuilder. In spite of the relatively decreased importance of the sailing ship, however, many important improvements have been made during the past few years, naturally rendered possible by the advances along all constructive lines. These improvements, as constituting the best practice of the day, it is the author's purpose to present in concrete and convenient form. Again, the author notes in the modern four- and five-masted ships and in the many-masted schooners—five, six, and seven—new problems which justify careful consideration in comparison with older and more standard practice.

The general subject is treated under three main heads. Under the first the author discusses the theoretical foundation upon which the practical art is based, and to which he will have occasion to refer. Here will be found an excellent brief discussion of the general topics of displacement, statical and dynamical stability, metacentric height, inclining experiment, center of gravity of ship and of cargo, freeboard, etc., etc. Under the second main head the author discusses the subject proper, masting and rigging. The subject is treated first in general terms, and then examples are given, with plans and computations in detail, drawn from practically all commercial types of sailing craft, and including three-, four-, and five-masted ships and barks, brigs, brigantines, and schooners from seven masts down, and with various combinations of square and fore-and-aft sails, yachts, fishing craft, etc. In a second section the masting and rigging of steamships is discussed with like detail and thoroughness. For each case a sail and rigging plan is shown on a folding plate, and all computations are given with full detail, together with body plan of the ship and diagram of the various geometrical quantities. Under the third main head the author discusses the various details connected with his subject, and illustrates the best approved forms of the various parts. This part of the work is of exceptional interest and value, and contains many tables and diagrams which would be most useful in connection with arranging the details of such work.

As a whole, the work forms a most notable addition to the literature of this subject. The treatment is comprehensive and full, replete with valuable information in both tabular and graphical forms, and would most certainly prove an invaluable aid to those having to deal with such problems in German practice, while to all it will be found a rich mine of information relating to this part of the marine constructor's field.

The Proportions and Movement of Slide Valves. By W. D. Wansbrough. Size 5 by 7 1-2 inches. Pp. 100, with 50 diagrams in the text. Manchester: The Technical Publishing Company. Price 4 shillings 6 pence.

This book is a reprint of a series of articles originally published in the *Mechanical World*. Inconvenient for general reference or for the study of a particular case,

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they are here republished in a more acceptable and convenient form. The subject matter consists of fifty cases of slide-valve analysis or design, covering all manner of problems relating to slide valves, either single or double, with or without an expansion plate, and with cut-off blocks of the "Meyer" type. For the solution of the first thirteen cases, constituting various forms of the problems of design for plain slide valves, a series of special constructions is given, but without attempt to relate them all to the few necessary principles involved. For most of the remaining cases, involving design and analysis, the Zeuner diagram is employed, with some modifications as found useful by the author.

The book, in effect, consists of a series of constructions, stated for the most part without reasoning or attempt at proof, and simply leading the designer along, step by step, to the end of his route, but without stimulating such study as should tend to make him independent of such aids. For the busy designer who may not wish for the reason why, and who is only desirous of reaching a given end, such a book may be of value. For the true student its chief value would be as a series of constructive exercises for which he might endeavor to work out the proofs.

From the author's point of view, however, the work is carefully and thoroughly done, and in the drawing office the book would certainly find use. The chief criticism, mechanically, is with the cuts. The same blocks have evidently been used as for the original publication, and many of them are much blurred, while in some of the more complicated the scale is so small as to make reference to them hard for the eyes. The book is printed and bound in the usual style of the publishers, and, for many purposes, should prove a useful contribution to the literature of slide-valve problems.

Beeson's Marine Directory, 1903. Harvey C. Beeson, 370 Dearborn street, Chicago, Ill. One volume, 250 pp. 6 1-2 by 9 1-2 inches. Price $5.

The sixteenth annual edition of Beeson's Marine Directory of the Northwest Lakes for 1903 has just been published. This book is a development of the directory published several years ago by the Lake Marine Service of Detroit under the Secretary of the Treasury. From its inception the Beeson's Directory has grown annually, and its contents embrace lists of American steam and sail vessels of the Lakes, giving their rig, dimensions, year and place of building, names of owners, insurance rating, etc.; lists of engines and boilers, with dimensions; list of Canadian vessels, both steam and sail; lists of vessel owners and shipmasters, besides articles of special value written for the work by well-known writers. The volume is well illustrated with views of vessels of all classes. It is printed on heavy paper and bound in red cloth.

New System of Awarding Machine-Shop Labor. By H. L. Gantt. A 12-page reprint from Cassier's Magazine, 3 West Twenty-ninth street, New York, N. Y. Price 10 cents.

The above-mentioned reprint deals with the various methods of encouraging increased production among workmen, especially in engineering works. No system has ever produced such satisfactory results as some form of a bonus system, but a bonus system without some method of imparting the necessary information both to the employer and the employee is not likely to prove workable. This pamphlet deals not only with the system, but with the method of accomplishing what the system aims to accomplish—increased production and satisfied workmen.

Steamer S. V. Luckenbach.—The oil-tank steamer *S V. Luckenbach* has been given up as lost. She left Sabine Pass March 21 for Philadelphia with a load of about a million gallons of oil assigned to the Sun Oil Company. She has not been reported since, and not a word has been heard of her captain or crew of 26 men.

Alco-Motor.—The Hamburg-American Line has been experimenting with a motor using alcohol as a source of power. The style of engine is like that of petroleum and benzine motors. It works after the 4-stroke system, and in such manner that at the first stroke alcohol and air mixed are drawn in, at the second stroke these are compressed, at the third stroke burnt through electrical ignition, and exhausted as burnt gas with the fourth stroke; consumption of 90 per cent. alcohol at about 0.6 kg. per hour and brake horse power.

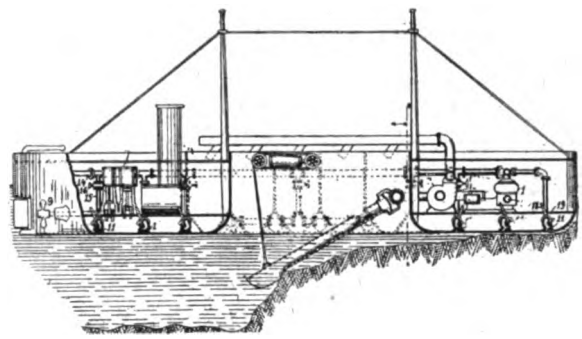
SELECTED MARINE PATENTS.

724,488. PROPELLER. RICHARD MURR, SEATTLE, WASH. Two claims.

724,486. BOAT PROPELLER. JOHN H. MILLIGAN, BALTIMORE, MD.

Claim.—1. In a device of the class described, the combination with a propeller shaft of a hinged frame movable either to an upright or a horizontal position, gearing carried by the hinged frame for rotating the propeller shaft, a brace composed of upper and lower sections hinged together in a right line, the upper section being also hinged to the said frame and being arranged longitudinally of the lower section or in an approximately vertical position to form a support for the lower section, and a seat mounted on the brace. Two claims.

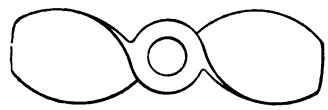
727,059. APPARATUS FOR RELIEVING GROUNDED VESSELS. GLEN E. BALCH, NEW YORK, N. Y.



Claim.—1. The combination with a vessel of a dredging apparatus, means for operating the dredging apparatus, pockets carried by the vessel for receiving the dredged material, a system of downwardly-opening jet nozzles at fixed points along the bottom of the vessel, and means for supplying the nozzles.

2. The combination with a vessel of a dredging apparatus, means for operating the dredging apparatus, pockets carried by the vessel for receiving the dredged material, a system of a downwardly-opening jet nozzles at fixed points along the bottom of the vessel, and a pump for supplying the nozzles. Seven claims.

724,935. PROPELLER. GEORGE QUICK, BOURNEMOUTH, ENGLAND.



Claim.—1. A screw propeller, the propelling surface of the blades of which from the hub outward toward the periphery is in the form of a concave curve, the said curved surface receding from the hub outward in the direction opposite to that in

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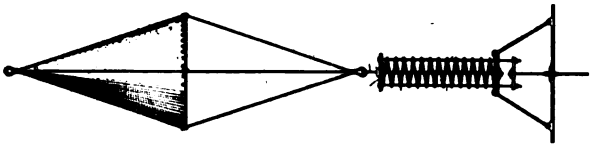
which the propeller turns to drive the ship ahead, and the angle of the said recession of the propelling surface diminishing from the hub outward to the end of the blade. Two claims.

726,947. COMBINED VENTILATING AND OBSERVING TUBE FOR SUBMARINE BOATS. SIMON LAKE, BRIDGEPORT, CONN.

Claim.—1. The combination with a submarine boat of a combined ventilating and observing tube passing through the wall of said boat and having its end portions normally in communication, respectively, with the interior and exterior of said boat, and provided also in its upper or outer end portion with a reflector or reflecting surface adapted to receive and reflect downwardly or inwardly through said tube into the boat an image of an external object. Seven claims.

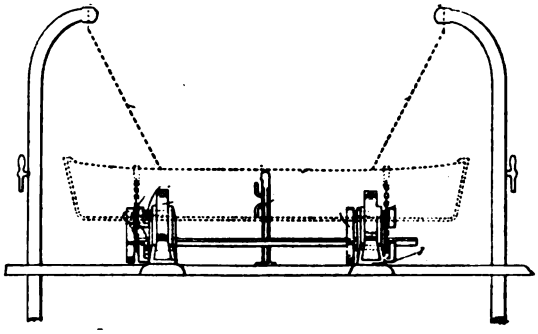
727,169. COUNTER-GRAVITY SCREW PROPELLER. CAREY A. MANKER, PEARL, ILL. Four claims.

727,175. SEA ANCHOR. THOMAS S. MILLER, SOUTH ORANGE, N. J.



Claim.—1. A sea anchor consisting of fixed and collapsible parts and mechanism whereby an increased resistance causes the collapsible part to collapse. Fifteen claims.

727,232. STOWING AND LOWERING OR RAISING BOATS. FRANCIS H. WADSWORTH, HELENSBURGH, SCOTLAND.



Claim.—1. Apparatus for lowering boats on shipboard, comprising inclined launching ways, and chocks in two parts mounted in said ways, both parts of the chock being adapted to slide together in said ways outboard, and means for securing the chocks in the launching ways. Eleven claims.

727,719. MAST HOOP. ROBERT W. VAIL, NEW YORK, N. Y.

Claim.—1. A mast hoop made up of two approximately semicircular sections of sheet metal concavo-convex in cross section, pivoted at their rear ends and terminating toward their front ends in cup-shaped members the convexities of which approach each other, and provided with means for securing such front ends together. Four claims.

727,774. SYSTEM OF COALING SHIPS AT SEA. ALEXANDER K. FINLAY, NEW ORLEANS, LA.

Claim.—1. In an apparatus for coaling ships at sea the combination with the collier and the vessel to be coaled of a tow line connecting the two, outriggers from the two vessels, one or more hauling lines connecting said outriggers, and one or more boats on each hauling line adapted to carry coal.

2. In an apparatus for coaling ships at sea the combination with a collier and a vessel to be coaled, a tow line connecting the two, outriggers projecting from each vessel, hauling lines connecting said outriggers, and boats completely housed over and adapted to carry coal, connected to said hauling lines. Two claims.

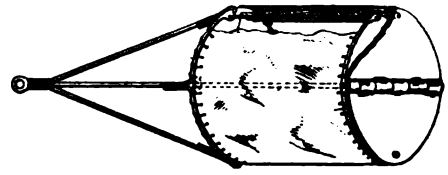
727,827. MARINE VESSEL. JOHN McMILLAN, BROOKLYN, N. Y. Four claims.

728,014. SUBMARINE CONSTRUCTION. LEONIDA L. RINALDI, SOMERVILLE, MASS.

Claim.—1. A submarine construction comprising building-blocks of concrete and arranged in superimposed layers, the ends of adjacent blocks in a layer having interlocking tongues and grooves extending from top to bottom of the blocks, and piles secured in and projecting downward from the bottom of the blocks forming the lowermost foundation layer. Five claims.

728,330. SEA ANCHOR. JOSEPH TEMPERLEY, LONDON, AND JOHN R. TEMPERLEY, BROMLEY, ENGLAND, AND THOMAS S. MILLER, SOUTH ORANGE, N. J.

Claim.—1. A sea anchor or drag comprising a series of retarding members attached one behind the other and a steering



surface extending substantially in the line of draft. Twelve claims.

728,553. NAVIGATIONAL SOUNDING APPARATUS. JOHN C. DOBBIE, GLASGOW, SCOTLAND.

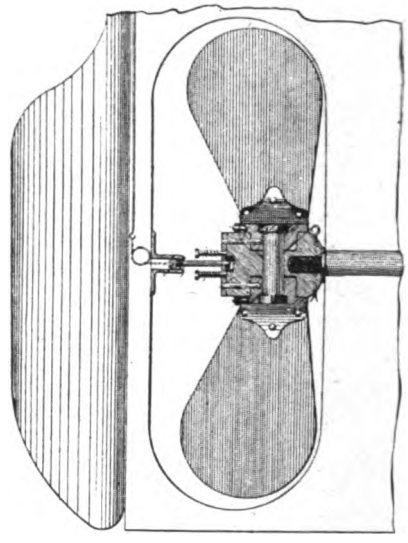
Claim.—1. Navigational sounding apparatus composed of a tubular casing closed at one end by a removable fluid-tight cover and furnished with an inlet tube having at its inner end a non-return valve formed by a rubber sleeve fitted over orifices in said tube.

2. In navigational sounding apparatus the combination with the water inlet of a non-return valve consisting of a tubular stem closed at one end and having a series of holes communicating with its central bore, these holes being covered by a rubber sleeve between which and the outer surface of the stem the water passes to the sounder casing. Five claims.

728,576. APPARATUS FOR PREVENTING THE RACING OF MARINE ENGINES. EDWARD HOPE, CHRISTCHURCH, NEW ZEALAND.

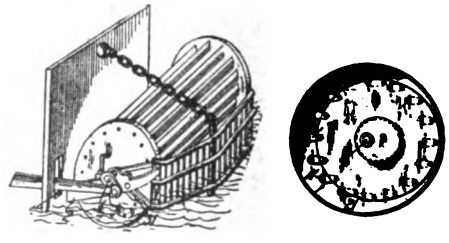
Claim.—2. In apparatus for preventing the racing of marine engines provided with a valve, a spindle having a spherical end, a pendulum having a hemispherical top the center of which is coincident with the center of the spherical end of the spindle, parallel ridges on the periphery of the said top gearing with a toothed wheel, and a recess in the pendulum top to receive the said spherical end of the hooked spindle. Five claims.

728,925. PROPELLER. EILT S. JACOBS, NEUHARLINGERSIEL, GERMANY.



Claim.—1. A propeller having blades mounted rotatably about an axis perpendicular to the shaft and unsymmetrically shaped with respect to their axis of rotation so as to automatically move under the water pressure; in combination with mechanism by means of which the blades may be secured either in line with the longitudinal perpendicular plane of the ship or in any position assumed upon rocking the blades about their axis. Three claims.

729,397. PROPELLER WHEEL. JOHN W. NOWAK. ALLEGHENY, PA.



Claim.—1. A device comprising in combination with a drive shaft, disks mounted thereon, blades or paddles journaled therein, stationary eccentrics carried by the shaft bearings, loosely-mounted disks carried by said eccentrics and connected with said paddles, and means for closing the first-named disks to enclose said eccentrics and loosely-mounted disks. Two claims.

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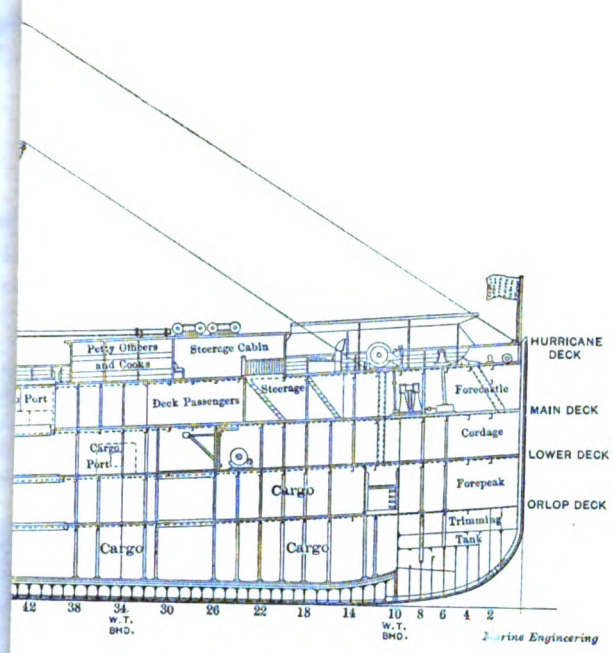

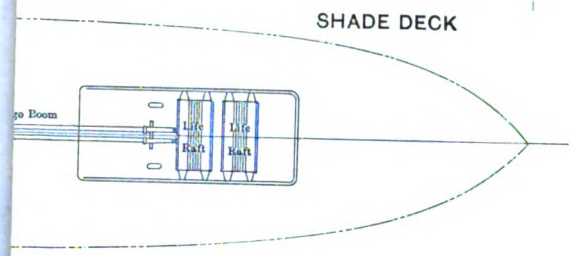

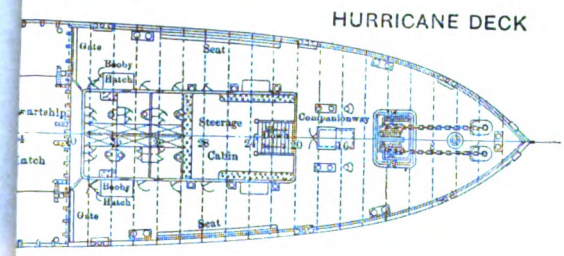

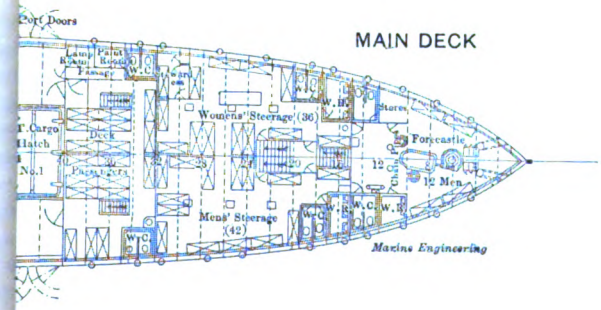

S SHIPBUILDING AND DRY-DOCK COMPANY.

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Marine Engineering

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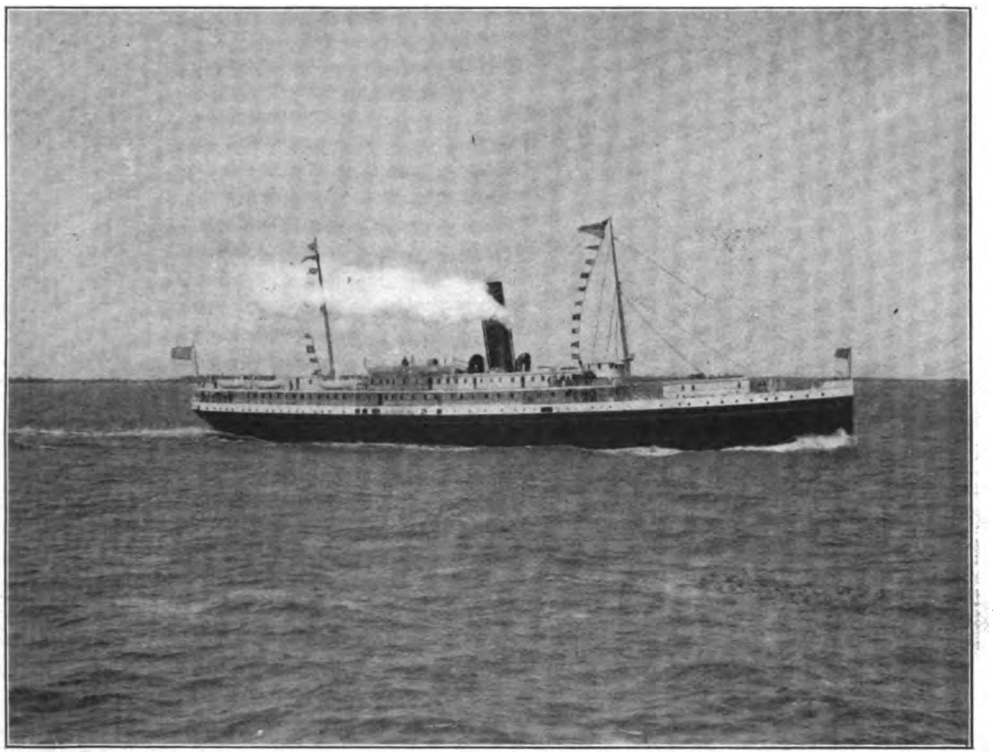
STEAMSHIP MONROE, OF THE OLD DOMINION LINE.

One of the finest steamers in any trade running out of New York harbor is the steamship *Monroe*, the latest addition to the fleet of the Old Dominion Steamship Company. This ship was recently completed by the Newport News Shipbuilding and Dry-Dock Company, and is for service on the main line of steamers plying between New York and Norfolk. The ships of this line have long been popular with passengers traveling along the coast, and the *Monroe* outranks the other vessels of the line in size and general features. She is a steel screw steamer of the hurricane-deck type, with complete hurricane deck, and partial shade deck extending from the foremast to the stern for the passenger accommodations. The hull is of steel to the hurricane deck, and all deck houses above are paneled joiner work. In general appearance she resembles the other ships of the Old Dominion fleet, but has more superstructure. Like them she is rigged as a two-masted schooner, with steel pole masts well raked. Her interior arrangement is, however, quite different, and in dimensions and power she exceeds them considerably. She was built to the rules of, and for the highest classification in, the American Bureau of Shipping for vessels in the coastwise trade, and was designed especially for the freight and passenger traffic, her accommodations for the latter being strictly first-class, while all necessary appliances for quick and easy handling of package freight have been provided.

Her principal dimensions will be found in the appended data card.



NEW COASTING STEAMER MONROE, OF THE OLD DOMINION LINE.

HULL CONSTRUCTION.

As indicated on the plans published herewith, she is a single-bottom ship with three complete decks, and orlop deck forward and aft of machinery space. She is built with continuous plate keel and keelson, the latter extending 16 1-2 inches above the floors with rider plate on top. The flat plate keel is 36 inches by 35 pounds reduced to 27 pounds forward, and is double for three-fifths length, the inner keel being 24 inches by 26 pounds for one-half length and 24 pounds for remainder. The center keelson is 22 pounds, connected to keel, floor stringers, and rider plate with double 6 by 4-inch by

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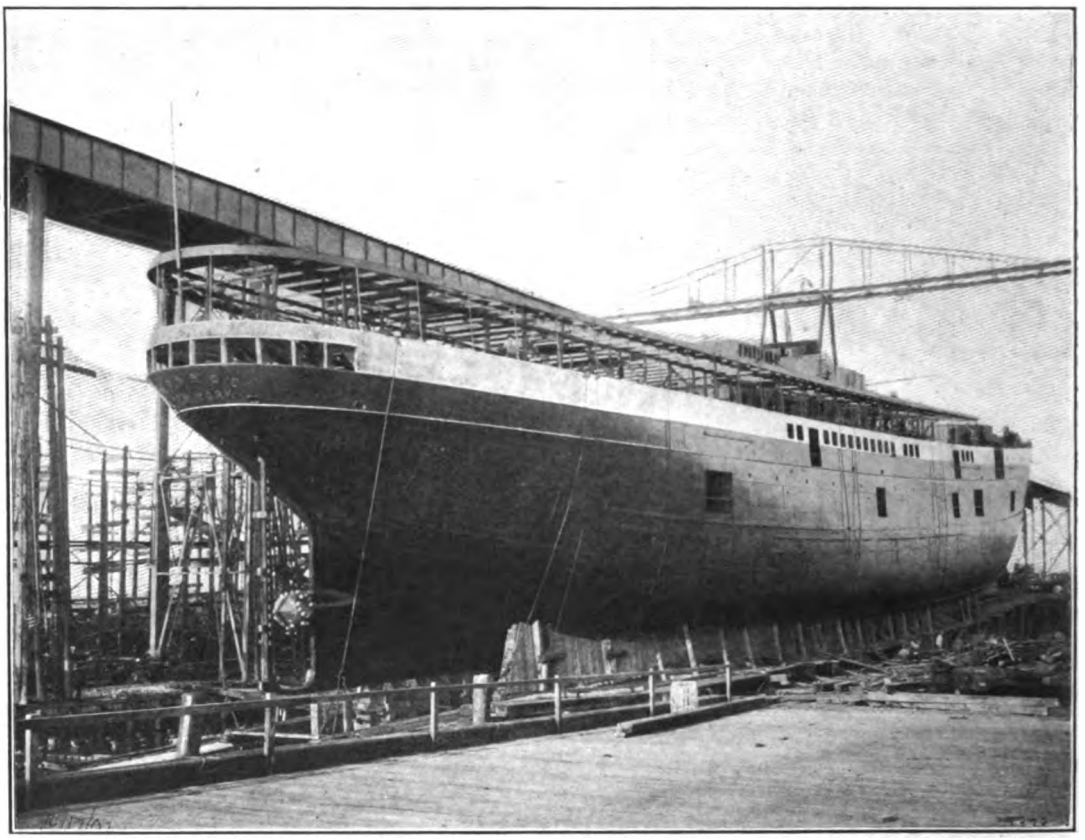
15-pound angles; the rider plate is 12 5-8 inches by 22 pounds for one-half length, reduced at ends; and the floor stringers on each side of center keelson are 21 3-4 inches by 22 pounds. The center line keelson is carried as far forward and aft as practicable and is rigidly connected to the stem and stern frame. The lower part of the stem is a steel casting shaped to suit the keel plate at its lower end and scarfed at its upper end to the wrought-iron stem proper, which is 10 1-2 by 2 3-4 inches. The stern frame is an iron forging 11 by 6 3-4 inches in the propeller post and 10 1-2 by 5 1-2 inches in the rudder frame, with all bosses for rudder pintles forged on. The rudder is of the double-plate type with forged frame and white pine filling. The frame is composed of a steel casting scarfed to a wrought-iron forging. There are four steel pintles, all fitted with brass sleeves and working in lignum-vitæ bushings. The rudder stock is a separate forging, bolted to the rudder through horizontal flanges. The weight of the rudder is taken by a flat deck plate with brass ring and a deep bearing lined with white metal.

The *Monroe* is framed with angle and reverse bars and fitted with solid floors on every frame, the latter being 29 inches by 21 pounds, with 24 pounds in machinery space and 16 pounds at ends. In the engine room deep floors are fitted to form the engine foundation. Frames are spaced 26 inches throughout the ship and are continuous from keel to hurricane deck from stem to the over-all hatch; for the remainder of length they extend to main and hurricane decks alternately. The main frames are 6 by 3 1-2 inches by 14 1-2 pounds to 13 pounds at ends, and reverse frames are 4 1-2 by 3 inches by 11 pounds throughout. The latter extend to main and hurricane decks alternately. Double frames are fitted at all water-tight bulkheads and in machinery space, and web frames 21 inches by 20 pounds are fitted to lower deck. Web frames are also fitted at each side of all cargo ports and in the cargo space between main and hurricane decks. There are three keelsons on each side in the lower hold. The upper and lower bilge keelsons have a 6 by 4-inch by 16 1-2 pound angle back to back, with a 10 by 3 1-2-inch by 26.5-pound bulb angle on inside of frames. The side keelsons are 15-pound plate fitted intercostally between floors and connected by single angle to shell and double angles on top of floors, all angles being 6 by 4 inches by 16 1-2 pounds. All keelsons run the entire length of the ship and form breast hooks at ends. Where they pass through the boiler space, the side and lower bilge keelsons form the foundation for the boiler saddles.



STERN VIEW OF THE STEAMER MONROE BEFORE LAUNCHING.

The shell plating is of the raised-and-sunken type with lapped butts and solid liners at frames in wake of outside strakes. The garboard strake is 26 pounds, bottom plating 24 pounds, bilge 27 pounds, side 22 pounds, main sheer 20 pounds, all plating being reduced at ends excepting around shaft boss. Doubling plates are fitted forward, from stem to aft of collision bulkhead, for protection against ice and from damage by

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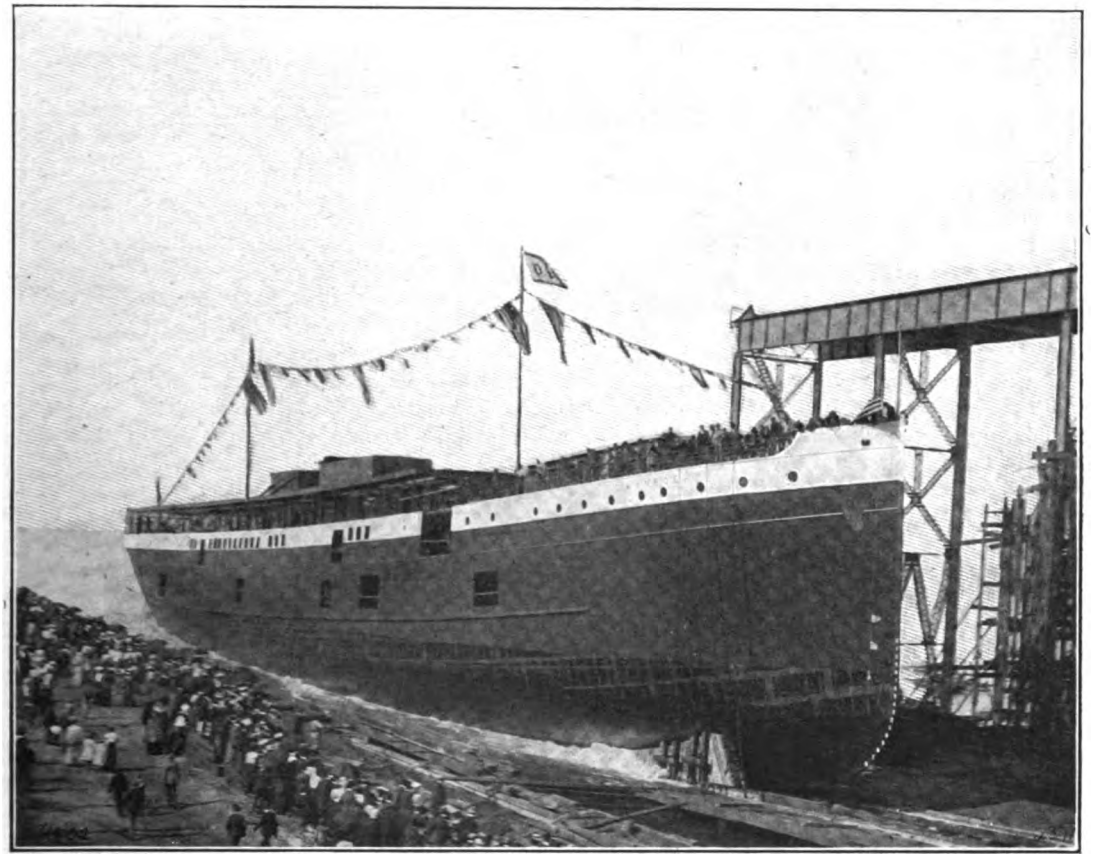
anchors. All lapped butts up to and including the main sheer are treble-riveted.

As previously stated, there are three principal decks and an orlop deck. All these have beams on alternate frames, the orlop deck having 11 1-2 by 5-inch by 35-pound bulb tee, the lower deck 12 by 3 9-16-inch by 31.83-pound channel, main deck 12 by 3 1-2-inch by 29.33-pound channel, and hurricane deck 8 by 3.4-inch by 23 1-2 pound channel. The shade deck has beams of 4 1-2 by 3-inch by 9.1-pound angles on alternate frames. The orlop deck has a 45-inch by 20-pound stringer, which runs continuous through boiler space, where it is 21 inches by 26 pounds. It is fitted with a calked deck of 4 by 6-inch yellow pine. In the after hold it forms the top of the shaft alley and also the top of the fresh-water tanks built on each side of the shaft alley just forward of the after-peak bulkhead. The lower deck is a complete steel deck with stringer 45 inches by 20 pounds, and 14-pound plating covered with a calked deck of 5 by 3-inch yellow pine. The main deck is also a complete steel deck with stringer 60 inches by 24 pounds, and 15-pound plating with a 3 3-4 by 3 3-4-inch yellow-pine calked deck. The hurricane deck is calked from stem to passenger accommodations; from there aft it is a white-pine deck canvased. The orlop and lower decks have waterways throughout, with scuppers to bilge. The main deck has a waterway forward of passenger accommodations and the hurricane deck has a waterway throughout, both fitted with scuppers discharging overboard. Solid stanchions are fitted for supporting all deck beams.

The hull is divided into four water-tight compartments by five thwartship water-tight bulkheads. These are located, as shown on plans, at the fore peak, in the fore hold, forward of coal bunker, aft of engine room, and at the after peak. The peak bulkheads extend to main deck and the others to lower deck. In addition there are three steel bulkheads dividing the coal bunkers and engine and boiler spaces. The bunkers are located at each end of the boiler room and extend to the lower deck, from which they are filled through scuttles. The coal capacity is 247.5 gross tons on a stowage basis of 45 cubic feet to the ton.



LAUNCHING OF STEAMER MONROE AT NEWPORT NEWS, VA.

The engine and boiler casings are steel throughout, extending to the top of the shade deck house. The enclosures for the firemen's quarters and the firemen's and crew's mess rooms are also steel.

The fresh-water capacity is about 25,000 gallons, of which part is in the tank built in the after hold and the remainder in two tanks located in the engine room.

PASSENGER ACCOMMODATIONS.

The passenger accommodations of the *Monroe* form one of the principal features of the ship. For the first-class passengers 61 state rooms are provided on the main deck aft of the machinery space and on the hurricane deck, while 11 state rooms for first-class colored passengers are provided on the shade deck. There are also

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accommodations for 54 second-class passengers, 78 steerage, and for 82 officers and crew.

The houses enclosing the state rooms on the hurricane and shade decks, as well as all outside woodwork, are paneled white pine. The interior of all passenger state rooms is finished in white pine painted white, and the rooms are fitted with two enameled iron berths each, the upper berth being arranged to fold up when not in use. Wide transom seats upholstered with hair cushions are fitted in nearly all state rooms, and all rooms have white enameled lavatories with water tank and receiver, cherry toilet racks, and cherry-framed mirrors. The state rooms on the main deck are fitted in groups of four, with alcoves between groups. The inner rooms are lighted through fanlights from the hurricane deck, and the outside rooms and alcoves by 16-inch air ports. Several of the outside rooms have connecting doors for party use.

The main saloon, alcoves, and all parts of the passenger accommodations aft, excepting the interior of the rooms, are finished in paneled mahogany.

Entrance to the main saloon on the main deck is from passages on each side abreast of the engine casing, through large sliding doors. Entering these the first thing to strike the eye is the main stairway leading to the social hall on the hurricane deck. This stairway, in conformity with the other joiner work, is paneled in mahogany, with open balustrade, the newels being crowned with fine electric clusters. The steps are covered with rubber treads with brass nose and toe plates.

At the landing of the stairs is the builder's nameplate, and directly above, in place of the conventional mirror, is a large life-size oil painting of President Monroe, representing him sitting at a desk with manuscript in hand. The painting was made by T. Jaensen and is a fine piece of art.

Directly above the main stairway is a large well, finished in white and gold, which is lighted by a skylight with a leaded glass dome below. The panels of the latter have green wreaths entwined with mauve ribbons on an opalescent background, the whole effect being very pleasing to the eye.

At the foot of the main stairway on the starboard side is the purser's office and state room, fitted with desk, sofa, rolling berth, etc., and finished in paneled quartered oak. Directly opposite is a large special state room fitted with a full-sized brass bed and a porcelain lavatory with running water. Opening from this room is a private bath room with solid porcelain tub with nickel-plated shower and fittings. The tub is set in porcelain tiling set in cement, and the sides of the room from deck to deck are covered with white tiling. The bath room is also connected to the two state rooms aft of it.

Wide transom seats upholstered with hair are placed in the main saloon and social hall, and when necessary could be used for berths. Bookcases are built in the joiner work on each side of main saloon. In addition to the lights from the air ports in the alcoves, the saloon is lighted through two wells in the hurricane deck.

The care which the Old Dominion Steamship Company takes of the comfort of its patrons is evidenced by the manner in which the *Monroe* is fitted, both in general and in detail. Although passengers on any single run are on the ship only a matter of about eighteen hours and such things are unusual on short-route ships, the *Monroe* is supplied with two bath rooms, one for men and one for women. These rooms are at the after end of the main saloon and are furnished with solid porcelain tubs with nickel-plated showers and fittings, lavatories, and all appurtenances of first-class bath rooms. Like the private bath, these rooms have tiled floors and side walls. Aft of the bath rooms are the main first-class toilets, which, like all other toilet rooms for first-class passengers, have tiled floors and a tile wainscoting four feet high. They have two porcelain lavatories each, with all first-class plumbing requisites.

The social hall and saloon on the hurricane deck is finished similar to that on the main deck. It is entered from deck at forward end through large sliding doors with storm doors outside, and entrance is also provided through passages at after end.

The saloons, alcoves, etc., are covered with Royal Wilton carpets, and rugs are provided for all state rooms. The predominating color of all furnishings is dark green.

At the after end the upper saloon is lighted by a fine mahogany skylight, which also lights the lower saloon through one of the light wells before mentioned. The sashes are fitted with lifting gear, thus providing means of ventilating the saloon.

Rising from the social hall about the middle of its length is a mahogany stairway which leads to the observation room on the shade deck. This room is a commodious one of paneled joiner work finished in white and gold, and is provided with upholstered transom seat, comfortable chairs, and a piano at the forward end. Over the stairway is a dome of joiner work with ornamental figured-glass panels. This room will doubtless be a favorite one in stormy weather for passengers who prefer being indoors. It is entered from the shade deck through mahogany sliding doors with glass panels in upper sash, and so it is easily accessible to a fine promenade, the shade deck from there aft being very open and clear. For those who prefer the open air there is plenty of space for promenading, the shade deck aft of the observation room and forward around the pilot house being thus available, while the hurricane deck from the foremast aft forms a splendid promenade at sides of houses and aft.

At the forward end of the hurricane-deck house is the first-class dining room, which extends the width of the house and has accommodations for 114 people. The interior woodwork is paneled white pine finished in white and gold, and the deck is covered with interlocking rubber tiling. In addition to a large number of windows on three sides, it is lighted through a well with a ribbed glass skylight above and leaded glass dome below. The well and the whole dining room are plentifully supplied with electric fixtures finished in Neptune green and when lighted at night present a very fine appearance. They were furnished by Page Bros., of Boston. The fittings in the dining room are all mahogany. At the after end of the dining room is a large mahogany sideboard with marble top and mirrors above. It is arranged with an ice box, and chill chamber for use as a wine locker. Six large electric fans are located in different parts of the dining saloon to provide additional ventilation. The room is entered by sliding doors on each side at the

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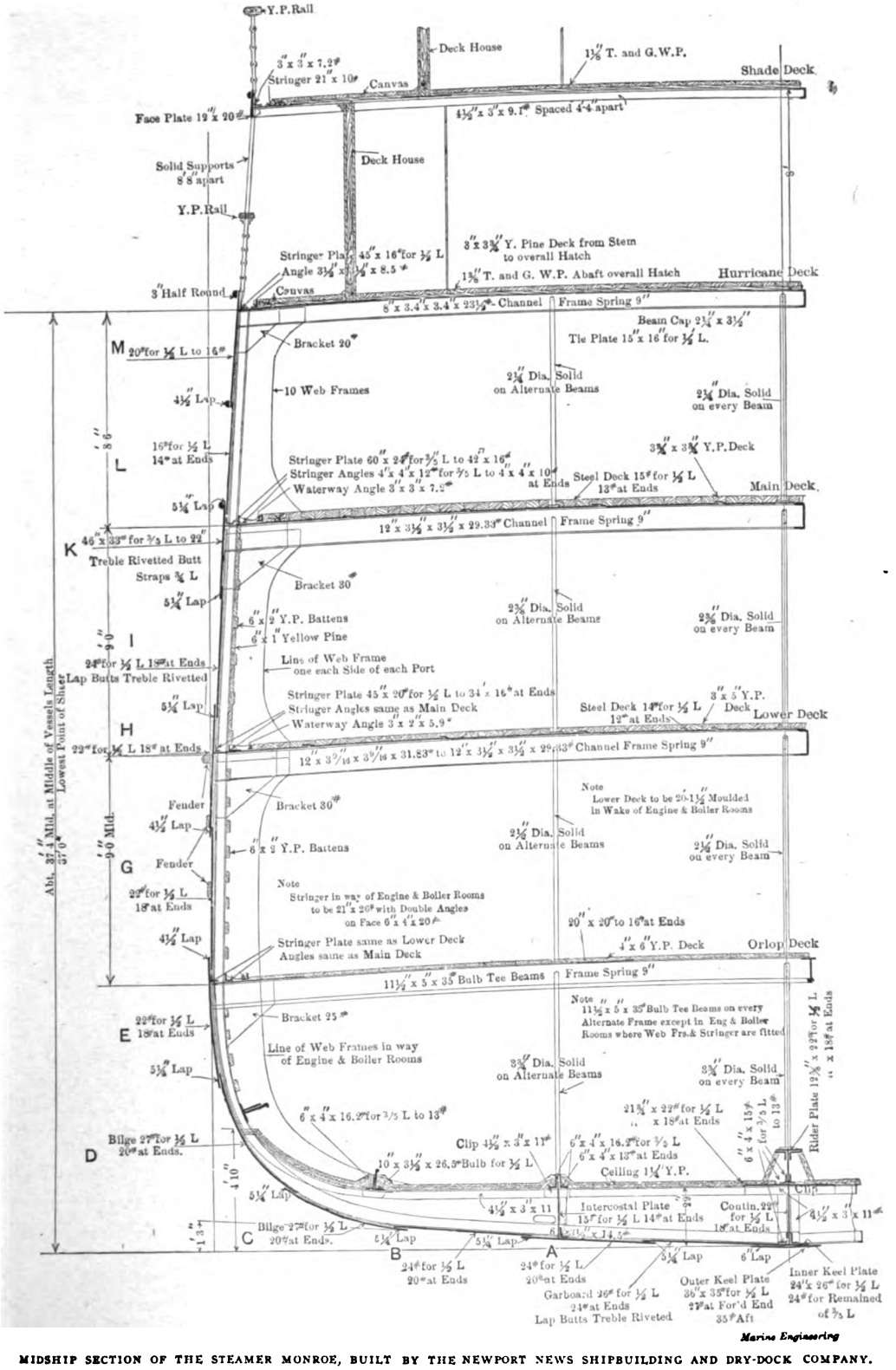
forward end and by an inside passage from the saloon on the starboard side. This passage leads between the machinery casings and a row of state rooms, is paneled similar to the saloons, and is finished in white and gold. A small skylight gives light and air to this passage. The steward's room is at the forward end just aft of the dining room. It is finished with high wainscoting of oak and fitted with oak desk, rolling berth,



MIDSHIP SECTION OF THE STEAMER MONROE, BUILT BY THE NEWPORT NEWS SHIPBUILDING AND DRY-DOCK COMPANY.

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etc. A toilet room for women is located at the after end of the inside passage.

Aft of the dining room on the port side is the first-class pantry, which extends the full length of the boiler casing and is fitted with a large refrigerator, steam table, three urns, two porcelain sinks, silver locker, etc., all wood fittings of mahogany. The deck is covered with interlocking rubber tiling. A large dumbwaiter is fitted at the after end of the pantry, with shaft extending from main to shade decks. The galley is located on the main deck between the engine and boiler casings, and all food to the dining rooms and mess room is transferred by the dumbwaiter. Fittings in the galley comprise a large range, vegetable kettle, broiler, sink, etc. The floor is covered with brick set in cement. A light and air well is located over the range and has hinged covers with deadlights, the covers being provided with suitable lifting gear.

Abreast of the engine casing on the starboard side is a large ice house in three sections. It is insulated with double thickness of sheet cork, T and G pine, and paper, and has a storage capacity of seven tons of ice. The galley store room is located on the port side just forward of the galley.

On each side of the galley is a stairway leading to an athwartship passage on the hurricane deck. Opening from this passage on the after side is the officers' mess room, with a seating capacity of 14, which is also accessible from the fore-and-aft passage, deck, and engine room. It is finished in paneled joiner work with a wainscoting and deck of oak, and all fittings are oak.

On the starboard side of the mess room leading from the athwartship passage, a mahogany stairway leads up to a dining room on the shade deck which is used for first-class colored passengers. This dining room extends the full width of the shade-deck house and is finished and furnished similarly to the main dining room. A dome of joiner work with ornamental glass is fitted similar to that over the observation room.

As previously stated, the state rooms on the shade deck are reserved for colored passengers, accommodations for 21 persons being provided. On the starboard side aft, a smoking room paneled in quartered oak is provided for their use. The deck in this room is covered with interlocking rubber tiling. The toilets are in all respects similar to the white passenger toilets. The shade deck abreast of these quarters is railed off for use as a promenade for colored passengers.

On the shade deck forward of the boiler casing is a fine, large, first-class smoking room, which is finished in paneled quartered oak and extends the width of the house. The deck is covered with interlocking rubber tiling. A skylight with leaded glass dome beneath adds much to the appearance of the room. An electric exhaust fan is fitted in the skylight for ventilating purposes. The smoking room is entered from the shade deck through sliding doors and from the hurricane deck by a large stairway leading from the fore-and-aft passage just aft of main dining room. A large toilet room, with fittings similar to the other toilets, is connected to the smoking room. In all the passenger accommodations all windows have mahogany frames and mahogany Venetian blinds, and all rooms opening on deck have mahogany Venetian doors. All sliding doors have glass sashes in upper panels and are fitted with storm doors.

Forward on the shade deck is a raised pilot house with bridge aft on level of top of deck house. The pilot house is finished in oak, with oak floor, and is fitted with all necessary navigating appliances. Aft of the pilot house, and connected to it by a small stairway, is the captain's room, which is finished in paneled quartered oak. This room is fitted with a brass bed, marble-top lavatory, quartered-oak desk and bookcase, lockers, drawers, etc. Quarters for the officers are also located on the shade deck aft of the captain's room, and are finished with high oak wainscoting.

Abreast of the officers' quarters, on each side of the ship, is a companionway with mahogany booby hatch and ladder leading to hurricane deck.

The chief engineer's room is on the port side of the hurricane deck abreast of the engine room, to which it is directly accessible. It is finished in paneled quartered oak, and fitted with rolling berth, desk, etc. The assistant engineers, oilers, and water-tenders are quartered on the main deck abreast of engine casing. An engineers' toilet is provided on this deck also, abreast of engine room.

Quarters for petty officers, cooks, and messmen are provided in six state rooms in a deck house on hurricane deck forward. All are fitted with enameled iron berths. Accommodations for 12 men are provided in the forecastle, for 18 firemen abreast of boiler casing on main deck, and for 21 waiters on the lower deck aft. These quarters are all fitted with metal stand berths and wire-mesh lockers. Separate toilets and wash rooms with showers are provided for the petty officers, crew, firemen, and waiters, the deck in all these toilets being covered with cement tile. Separate mess rooms for the crew and firemen are placed abreast of boiler casing on port side.

On the main deck aft of forecastle are steerage quarters for 42 men and 36 women. Each steerage has a wash room and toilet, the deck in these being covered with cement tile. Access to the steerage quarters is by oak stairways leading from the steerage cabin on the hurricane deck, this cabin being located in the forward end of hurricane deck house.

Aft of the steerage quarters, in a steel enclosure, are berths and space for 54 deck passengers. When not used for passengers this space may be used for cargo; companionways with steel booby hatches give access to it from the hurricane deck, and doors in the after bulkhead give access from main deck. The main deck aft of the deck-passenger space is provided with hammock hooks for use when carrying seamen between the New York and Norfolk Navy Yards. All quarters throughout the ship are supplied with steam heat.

Lamp and paint rooms are fitted abreast of deck-passenger space and divided from the latter by a passage with steel bulkheads.

FREIGHT SPACE.

Arrangements for handling and stowing freight on the *Monroe* are very complete. The lower hold space between orlop and lower decks is divided into three compartments, with large hatches to each. The main deck has one large hatch directly over No. 2 hatch in lower deck. No. 1 and No. 2 holds on lower deck are connected by two double-hinged water-tight doors for use in loading and unloading freight. The main hatch is

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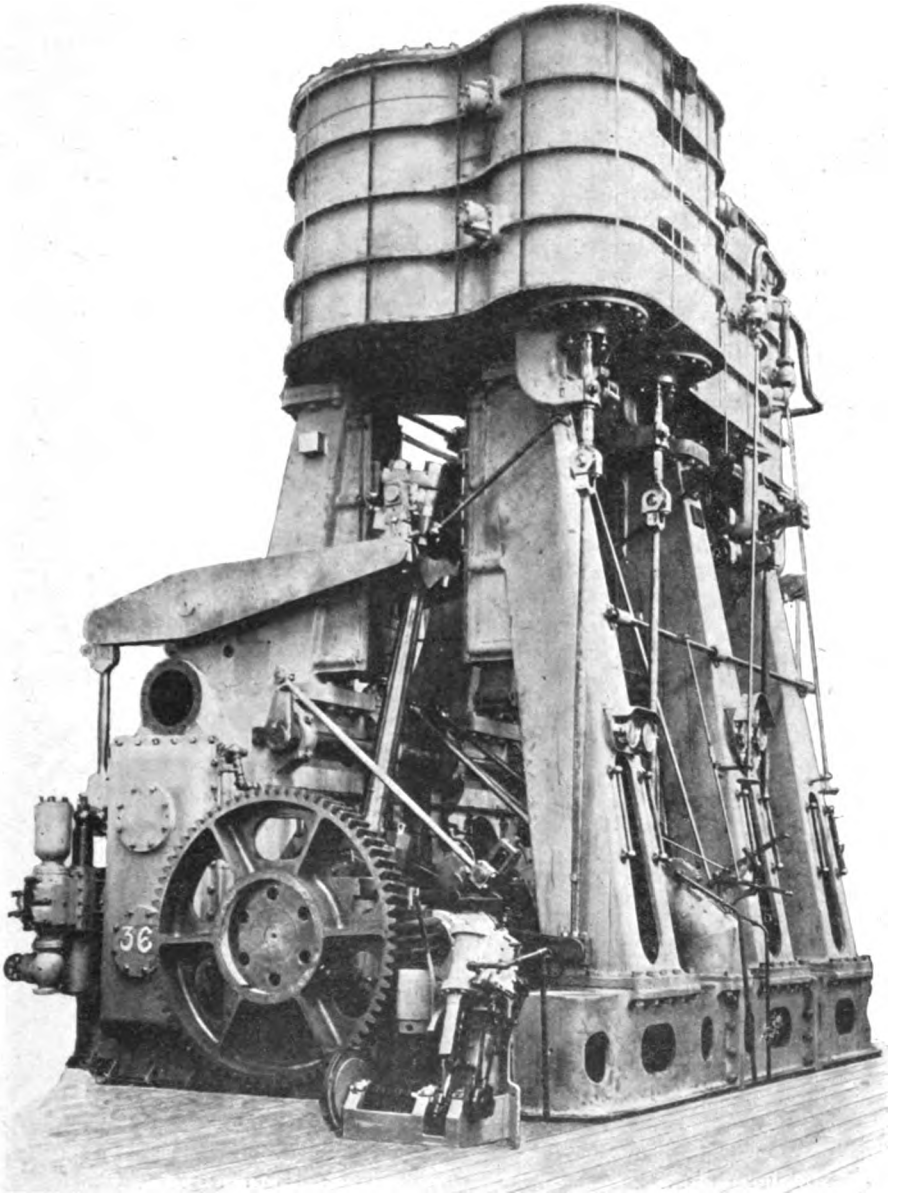
worked by two cargo cranes through two double-cylinder, 8 1-4 by 10-inch, single-drum Hyde winches. The hatches on the lower deck to the forward and after holds have each a double-drum winch, 6 1-4 by 8 inches, with cargo cranes for each drum.

In addition to the regular hatches, two hatches 8 by 7 feet are fitted in the forward hold and two aft in which steam freight elevators are placed. These elevators are operated separately by double 7 by 10-inch engines fitted with automatic stops. The elevators and gear were supplied by the Otis Elevator Company. Cargo cranes are also placed at each elevator hatch and are operated from the elevator engines.

The cargo ports for access to the lower deck are worthy of notice. Of these there are two 6 feet 3 inches by 9 feet and one 5 1-2 by 7 1-2 feet on each side. These ports are arranged to slide on an overhead track and are fitted with the usual arrangements for making water-tight. Each port has a small hinged door which is used in connection with opening the port, and can also be opened at sea in fair weather so as to provide additional ventilation to between-deck space.

In addition to the above ports, two coaling ports, 5 1-2 by 5 1-2 feet, are fitted on each side opposite the coal bunkers, thus making an easily-coaled ship. These ports are hinged in two sections and may also be used as freight ports.

On the main deck opposite the hatch is a large port with hinged door in sections; large hinged ports are also provided for handling baggage; and passenger gangways are provided in the passages forward of the main saloon. Two baggage rooms are located on this deck forward of the boiler casing and are enclosed with wire-mesh bulkheads arranged in panels to hinge up under



THREE-CYLINDER, TRIPLE-EXPANSION ENGINES FOR THE STEAMER MONROE, OF THE OLD DOMINION LINE.

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the deck beams when not in use. This arrangement makes them available for cargo when desired. Arrangements are also made for carrying horses on the main deck when required, the stalls for this purpose being portable. Between the cargo ports and the passenger accommodations on this deck hinged steel shutters are fitted which provide ventilation to the cargo space and for the firemen's quarters. Twelve-inch side lights are fitted in each shutter.

The available cargo space of the *Monroe* is about 217,000 cubic feet, including the baggage room. This also includes the combustible store room aft of the engine casing on the lower deck, which is a steel enclosure for matches and cartridges. In the holds cargo battens are run on the frames; and 'tween decks the sides of the ship and machinery casings are close-ceiled, the latter being also insulated with magnesia.

In addition to the cowls provided for natural ventilation, a complete system of artificial ventilation is provided for the cargo space on lower deck, on which large quantities of vegetables and perishable goods are carried. This system consists of separate supply and exhaust fans, one set located on the main deck forward and the other on the shade deck aft, the discharge duct of the latter leading down through the passenger accommodations forward of the mainmast, with which it is encased. The ducts run under the main-deck beams on each side of ship, and the supply ducts have branches to ship's side every ten feet, these branches running between the ceiling and ship's side to within twelve inches of the lower deck. The ventilating fans are Sturtevant steel plate, 70 inches diameter, driven by electric motors.

DECK EQUIPMENT.

The deck equipment of the *Monroe* is very complete, comprising steam steering gear, steam windlass, capstans, etc. The steering engine is of the Sickles type, and is located on the main deck under the pilot house. The leads from the engine run under the hurricane deck to the passenger quarters, aft of which they run on top of deck to a large quadrant located above the hurricane deck. Auxiliary steering gear of the Napier type is also fitted on this deck.

A Hyde steam windlass is located on the hurricane deck forward of the windlass engine, which is double, 10 by 10 inch, being located on the main deck and driving the windlass through a vertical shaft. A capstan on the hurricane deck is also driven through gearing by the windlass engine. Aft of the quarters on the main deck is another capstan, with an 8 by 8-inch vertical engine.

Bower anchors of the Baldt cast-steel stockless type, 5,500 pounds each, are stowed in the hawse pipes, and 210 fathoms of 2-inch stud-link chain are stowed below.

Capacity for 365 persons has been provided for in nine 24-foot metallic lifeboats and four Carley liferafts. The boat davits are of the hinged type. There is a complete set of awnings on the hurricane deck forward, all around the shade deck, and on top of the shade-deck house over the officers' quarters and smoking room.

An 18-inch bell is fitted on the foremast.

Blake duplex pumps, 5 1-4 by 3 1-2 by 6 inches, with hand attachment, are fitted in the forecastle and on the main deck aft for use in washing decks, etc.

A large and fully-equipped electric plant is another of the *Monroe's* features. It consists of three 25-K. W., 125-volt General Electric generators, driven by Harrisburg Ideal single-cylinder, horizontal engines with cylinders 8 by 10 inches, all located in the lower engine room. The ship is wired for over 800 16 candle power lights, exclusive of electric running lights. An 18-inch searchlight is mounted on the foremast and is operated from the pilot house.

MACHINERY.

The main engine of the *Monroe* is of the direct-acting, inverted-cylinder, triple-expansion type with cylinders 33, 52, and 84 inches diameter, respectively, and 54 inches stroke. The high-pressure cylinder is fitted with a working liner, and all cylinders have piston valves, the high-pressure having one 13 inches diameter, the intermediate one 25 inches diameter, and the low-pressure two 25 inches diameter. All valves are located on the starboard side of the engine and are operated by radial gear of the Marshall type. All pistons are cast iron, with follower and spring rings. The piston rods are steel, 7 1-2 inches diameter, and are secured to pistons and crossheads by taper end with nuts. Crossheads are of forged steel, with double gudgeons 8 1-2 inches diameter by 9 1-2 inches, and are fitted with double cast-iron slippers lined with white metal. The connecting rods are forged steel, 122 inches between centers, with forked upper end, and taper from 7 to 8 3-4 inches diameter. Brass boxes are fitted for gudgeon and crank-pin bearings, the crank-pin boxes being also lined with white metal.

The cylinders are supported on cast-iron housings of box section, with slipper slides bolted to each. The front housings rest directly on the bed plate, and the back housings on the surface condenser, which is built into the engine framing.

The bed plate is a deep box section of cast iron in three sections, and has five main bearings, three 17 3-4 inches long and two 29 1-2 inches long. These are fitted with cast-steel boxes lined with anti-friction metal, and have separate binders of wrought iron.

The crank shaft is forged steel, 16 inches diameter, of the built-up type, in two sections, with wrought-iron crank webs set at 120 degrees apart in the usual sequence; the crank pins are 16 inches diameter by 16 1-2 inches long. The thrust shaft is 15 1-2 inches diameter, with separate thrust collars for ahead and astern, eleven collars for the former and six for the latter, all being 23 1-2 inches diameter. The thrust is taken on white metal faces by cast-iron bearings of the full-ring type, the whole provided with water circulation.

All line shafts are 15 1-4 inches diameter and are supported on steady bearings located from 16 feet to 20 feet apart. The tail shaft is 17 inches diameter, brass-lined in stern-tube bearings. The latter are brass sleeves lined with lignum vitæ. The stern tube is cast iron.

A sectional four-bladed propeller with cast-iron hub and cast-steel blades is fitted. It has a diameter of 17 feet with 21 feet 6 inches pitch.

As previously stated, the condenser is built into the engine framing. It has a cooling surface of 7,280 square feet with 1,710 3-4-inch brass tubes. The circulating water enters at the bottom and discharges from the top. A centrifugal pump with 17-inch suction and discharge circulates water through the condenser and is driven by an 11 by 11-inch single-cylinder engine.

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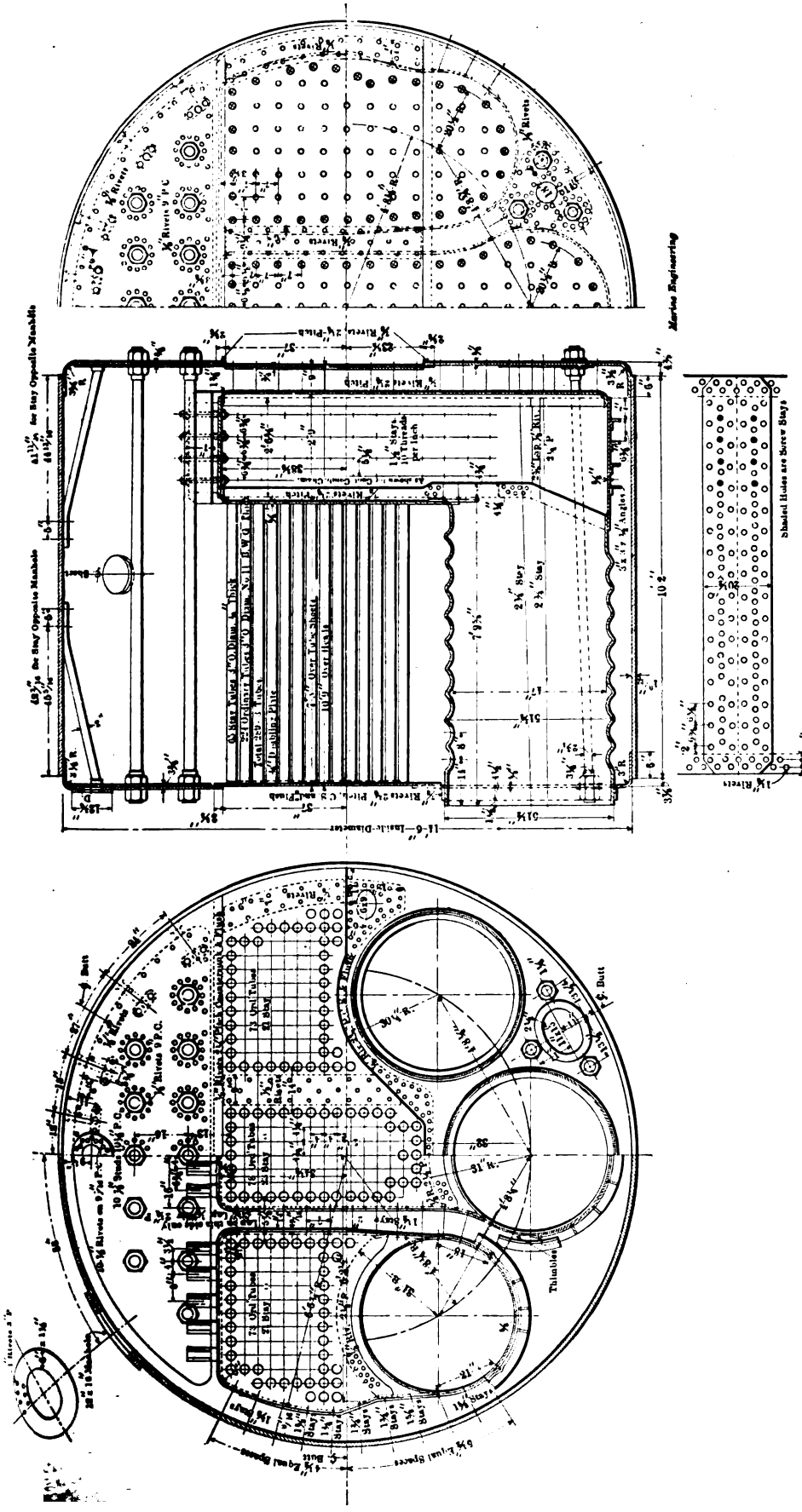

ONE OF THE SIX 3-FURNACE SCOTCH RETURN TUBULAR BOILERS BUILT BY THE NEWPORT NEWS SHIPBUILDING AND DRY-DOCK COMPANY FOR STEAMER MONROE.

The main air pump is 32 inches diameter by 25 inches stroke and is driven from the L. P. crosshead. Two 6 1-2-inch bilge pumps are also attached to the main engine. For the use of auxiliary machinery when in port an auxiliary condenser with 600 square feet of cooling surface has been provided. It is fitted with an independent centrifugal circulating pump with 8-inch suction and 7-inch discharge, driven by a single 5 by 6-inch engine. This pump is also connected to the main condenser for use in emergencies. Steam turning gear with a single-cylinder engine, 8 by 8 inches, fitted with link valve gear, is provided. It is located on the after engine-room bulkhead and operates through worm gearing.

With the exception of the air pump and attached bilge pump, all auxiliaries are independent. For feed pumps two Blake vertical simplex pumps, 14 by 10 by 18 inches, are fitted. All other pumps are Blake also and comprise an 8 by 7 by 12-inch horizontal duplex fire and bilge pump, one 4 1-2 by 2 by 4-inch horizontal duplex feed pump for donkey boiler, a 4 1-2 by 4 by 6-inch vertical simplex pump for fresh-water service, and an 8 by 8 by 12-inch vertical simplex sanitary pump.

BOILERS.

The boiler-room equipment consists of six Scotch

boilers arranged with their axes athwartship, thus making a fore-and-aft fire room. A vertical donkey boiler 6 feet in diameter by 11 feet high is located on the lower deck. Each main boiler is 14 feet 6 inches diameter by 10 feet 9 inches long, with a working pressure of 175 pounds. There are three 47-inch Morison furnaces in each boiler and 289 three-inch tubes, each furnace having its own combustion chamber. The total heating surface is 12,288 square feet and total grate surface 441 square feet. The boilers are fitted with dry pipes, internal feed pipes, all necessary stops, feed and blow-off valves. A Mossman circulator is fitted in the feed pipe of each boiler for circulating the water, and all boilers are connected to one main elliptical stack.

For ventilating the fire rooms four 35-inch cowl ventilators are provided, and in addition there are two steam-driven Sturtevant fans to assist the natural ventilation. These fans are located near the top of the fidley and draw air through the open gratings above, discharging through the regular ventilating ducts. The fans are 54 inches diameter with 19-inch tip, and are driven by compound single-acting engines 5 1-2 by 10 by 5 1-2 inches.

From stem to stern the *Monroe* is a well-built and finely-finished ship, complete in all particulars, and ably sustains the reputation of the Atlantic coast for having as fine a fleet of passenger and freight steamers as can be found the world over.

Name—Monroe. **Nationality**—American. **Type**—Coasting passenger and freight.
Launched—1902. **Builder**—Newport News S. B. & D. D. Company. **Owner**—Old Dominion Steamship Company.

Length over all	366 ft.
" between perps	344 "
Beam molded	46 "
Depth to hurricane deck at lowest point of sheer	37 " 6 ins.
Depth to main deck	28 " 6 "
" " lower "	19 " 6 "
" " orlop "	10 " 6 "
Block coefficient	.66
Prismatic "	.703
Midship "	.93
Displacement at 18 ft	5,375 tons
Cargo space	217,000 cu. ft.
Coal capacity	247.5 tons
Engines: Type	single, triple-expansion
Cylinders, diam	33, 52, 84 ins.
Stroke	54 "
Valves	all piston; H. P. 13 ins.; M. P. 25 ins.; two L. P. 25 ins.
Gear	Marshall radial
Piston rods, diam	7 1-2 ins.
Connect. rods, length between centers	122 "
Connect. rods, diam	7 ins. to 8 3-4 "
Shafting, crank and pins diam	16 ins.
" thrust	15 1-2 ins.
" collars	23 1-2 "
11 collars for ahead; 6 collars for astern	
" line	15 1-4 ins.
" tail	17 "
Condens. surf	7,280 sq. ft.
Tubes	1,710 3-4-in.
Auxiliary condens	600 sq. ft.
Air pump, D. C	32 ins diam. by 25 ins.
Feed pumps	2 simplex, 14 by 10 by 18 ins.
Electric light plant	3 25 K. W. single
Propeller	cast-iron hub, 4 steel blades
Diam	17 ft.
Pitch	21 ft. 6 ins.
Boilers: number	6 S. E. Scotch
Diam	14 ft. 6 ins.
Length	10 " 9 "
Pressure	175 lbs.
Furnaces	3 Morison in each
Diam	47 ins.
Tubes, each boiler	289 3-inch
H. S. total	12,288 sq. ft.
G. S. total	441 "

USES OF ELECTRICITY ON BOARD SHIP.—II.

BY J. W. KELLOGG.

CARE OF GENERATORS.

In electric-generating sets troubles are usually due to the engine driving the set rather than to the generator. In a well-constructed generator there is very little to get out of order. With the conservative heat ratings that are given with all first-class machines to-day it is practically impossible to so overload the machines as to cause burn-outs. The principal troubles from overloads will be more on the commutator, through sparking and troubles with the brushes, than from any liability of burn-outs. The armature should be protected from any oil or dirt getting into the winding. Oil is very injurious, not only to the insulation on the armatures, but to all insulation on the conductors as well.

With the carbon brush, which is used universally at this time, there is very little care required in the setting of the brushes. A machine that operates properly will soon get a perfect glaze on the commutator, and there will then be very little wear to either commutator or brushes. A piece of sandpaper fastened around the commutator will shape the brushes so as to make them fit the commutator perfectly in a very few minutes.

There are sometimes troubles in getting a generator to build up after it has stood for a long time and the magnetism has left the fields. It is then necessary to excite the fields from a separate source of power. In starting up a machine, if there is trouble in getting the machine to build up, see that the brushes are in good contact with the commutator and that all the connections of the machine are well made. Only in very exceptional cases will it be found impossible to get current from the machine if there is no external resistance in the field circuit.

CURRENT, WIRING, AND INSULATION.

On generators and motors, and practically all appliances furnished for use on shipboard at the present day, such parts as are liable to corrosion—bolts, nuts, screws, washers, and exposed parts in the wiring appliances—are made of non-corrosive metal. Safety appliances, such as circuit breakers and fuses, are installed at convenient points, so that in case of overloading of any conductors the safety appliances will operate, thus eliminating the danger from fire. The underwriters' rules and practice of all reliable concerns to-day insure the installation of electric plants in such a way as to render fire risk practically nothing.

The original voltage used was in the neighborhood of 50, which, in a measure, accounts for the absence of trouble due to poor insulation of the wires. The voltage for the navy was afterward changed to 65 and a little later to 80, a board having been appointed and adopted this voltage as one being generally used by different governments. With the increasing size of installations and the corresponding increased current to be carried, it has been found impracticable to use as low a pressure as 80 volts, and on the first plants where a large number of auxiliaries were to be operated by electric motors the mains for the power circuits were run on the three-wire system and the motors wound for 160 volts. The incandescent lamps were still operated on the 80-volt circuits.

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A short time ago the Navy Department changed the standard voltage to 125, and the motors and lights are all operated at this voltage. For merchant ships the voltage for lighting has been established at 110 for some years; and now that the use of electric motors is growing, motors are being installed to operate on the three-wire system at 220 volts. Machines used at the present time are all direct-current compound wound, designed to operate at 300 to 500 revolutions a minute.

STEAM TURBINE.

The alternating-current motor is well adapted for use on shipboard, and it is believed that in the near future alternating-current installations will be made on account of the simplicity of the induction motor. The use of the steam turbine will tend to bring this about, as the design of electric machines for direct connection to steam turbines can be best undertaken by the use of alternating-current machines. The steam turbine is ideal for ship work; it has the advantages of freedom from vibration, high efficiency under all conditions of load, light weight, possibility of using high pressure of steam, and freedom from wear owing to the lack of reciprocating parts. At the present time the developments in this class of apparatus are so rapid it seems certain that in the near future the turbine-driven sets will be universally used for the electric plants on board ships, from which power can be taken and distributed to electric motors on all sorts of auxiliaries. The advantages over the steam engine are very great, and it is hard to find any disadvantages.

CURRENT DISTRIBUTION.

The circuits from the main generators are generally carried to a switchboard conveniently placed, usually in the dynamo room, and from there through switches and cut-outs or circuit breakers to the different parts of the ship. It is customary, in plants used primarily for lighting, to run mains from the switchboard to two or three distributing points on the ship where a panel is installed in a lead-lined box, while in some cases, where it is not damp, the box is asbestos-lined. Circuits of from eight to ten lights even are led off from the main through switches and cut-outs mounted on these panels. This makes practically a fire-proof junction point, and with this subdivision of the lights the dangers from faulty circuits are minimized. These distributing boards are usually placed in some passageway where the switch can be reached without interfering with the passengers, and where they are not exposed to interference by people who are not authorized to handle them.

SINGLE- AND DOUBLE-WIRE CIRCUITS.

In most of the freight steamers built in England single-wire systems of distribution are employed. In some ships of the American Line in this country it is used, but generally the two-wire system is the one employed. In the single-wire system the hull of the ship is used for the return of the current. It is claimed for this that any defects that develop are more easily located and remedied, that it is only necessary to keep one circuit free from grounds and in good order, while but one-half the copper is required.

It has always been the belief of most engineers in this country that the single-wire system might give trouble from faulty contacts in the return circuit; if there were not perfect electric connection between the plates of the hull of the vessel, corrosion might take place at all joints. It is probable that in the plants that have already been installed the uses of the current have been limited to lighting and that no very large amount has been carried, in which case no faults should be expected to develop. With the use of very large motors for the auxiliaries and handling the winches, windlass, and steering gear, where very large power is distributed, it would be necessary to have the metallic circuit for return perfect and sufficiently large to carry the current. In one of the latest installations on a large ocean freight and passenger-carrying steamer, circuits of 1,000,000 circular mils cables are being installed, and it is expected that there may be rushes of current up to 2,000 amperes.*

In the two-wire system the mains are carried to all outlets and the flow of the current is confined entirely to the copper wires themselves, which are both insulated and kept entirely separate from the hull of the vessel. Double pole switches and cut-outs are installed, and any excess current in either wire of the system at any point will be taken care of.

It is customary to install the circuits on the ship so that each individual circuit has an insulation resistance of at least one megohm. The insulation, when all the circuits of the machine are connected, should not show less than 100,000 ohms, and in most cases it will be very much higher. Grounds are usually located by means of lamps on the switchboard which have a connection to the ground and to either side of the circuit. Thus, when there is a ground the lamps burn dimly or brightly, according to the side on which it occurs.

THREE-WIRE CIRCUIT.

When it is desired to operate the lights on a low-voltage circuit and the motors at a higher voltage on account of the large currents that have to be handled in the conductors, on the commutator, and on the controlling appliances, the three-wire system is often employed, in which the voltage between the two outside wires is double that between either outside and intermediate wire. The lights can be carried on circuits connected to either of the outside wires and the middle wire, and the motors on circuits to the two outside wires. The generators are wound for the low voltage; the circuits are carried to them in such a way that the two outside wires are run from positive side on one machine and negative on the other, the middle wire being connected to the other positive and negative terminal of each machine. The two generators are thus operated in series, and the current on the outside wires will be at a voltage double that of each machine.

In some cases, principally on naval vessels, where it is desired to have the additional precaution of two sources of supply in case of failure of any circuit, a double set of wires is run to some distribution point, usually on opposite sides of the vessel. A switch is placed at some convenient point in the circuit in such a way that current can be fed through the distribution point from either set of mains.

*A circular mil is the measurement of cross-sectional area of a wire; a wire .1 inch diameter having 10,000 c. m., one of .2 inch diameter having 40,000 c. m., etc.

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For running lights, such as the masthead, side lights, and towing lights, where it is essential that the light burn continuously for certain hours, it is common practice to install two lights in each lantern, with a set of three-wire mains running from an indicator in the pilot house to each light, the switch on the indicator in the pilot house being so arranged that it can be shifted between the middle wire and either of the outside wires. When the lamp that is connected on one side is burned out the switch is simply thrown over to the wires connecting the other lights. The failure of either light is indicated by a buzzer or pilot light in the pilot house.

SIZE AND LOCATION OF WIRES.

The determination of the size of the wires for ship work is usually done from the Underwriters' Tables, which give a safe carrying capacity for each size wire. The distances are usually so short that a wire of sufficient size to carry the current in compliance with these rules is large enough to take care of any drop in the circuit. From 2 to 3 volts drop from the dynamos to the furthest lamp is allowed, and the variation of voltages on any lamps should not be over 2 to 3 per cent. In case the distance is so great that the drop has to be taken into consideration, the size of the wire is determined as follows for direct-current installations:

$$CM = \frac{L \times C \times 10.8}{\text{Volt loss in line}}.$$

L = total length of wire used. C = current in amperes.

The mains are usually led along the passages on the main deck; if in pipes, under the beams; and if through insulators, the beams are drilled and the wires led up close to the deck. This is generally found to be a location where there is the least exposure to mechanical injury or injuries from any causes, such as heat and moisture. Wires are not led through the freight spaces and it is not desirable to lead them through engine and boiler rooms; they can be located on the fore and aft bulkheads on the main passageways without cutting through water-tight compartments or main bulkheads.

(To be continued.)

Pacific Cable Completed.

On July 4 President Roosevelt sent a telegram to Governor Taft at Manila over the new Pacific cable laid by the Commercial Cable Company. The message was sent from Oyster Bay late at night and was as follows:

Governor Taft, Manila:

I open the American-Pacific cable with greetings to you and the people of the Philippines.

THEODORE ROOSEVELT.

The route of this cable extends from San Francisco to Honolulu, 2,276 miles, which was opened on December 26 last year, and which was described in MARINE ENGINEERING, February, 1903. The next stretch is to Midway Island, 1,256 miles; the third stretch is from the Midway Island to Guam, 2,593 miles; while the fourth section is 1,490 miles, from Guam to Luzon in the Philippines. The connecting link was made at Honolulu by splicing the western cable with the eastern section. Thus was completed the transpacific, all-American cable.

13,000-ton Battleships.

The sketch plans of the 13,000-ton battleships *Idaho* and *Mississippi* have been approved by the Secretary of the Navy. The general dimensions of each will be: length, 375 feet; breadth, 77 feet; mean draft, 24 feet 6 inches; indicated horse power, 10,000; and trial speed of from 16 1-2 to 17 knots. In submitting the plans the Board of Construction informed Secretary Moody that it had concluded that the "intent of the act would be best complied with, and the interest of the navy furthered under this act, by retaining for the vessels in question as nearly as possible the offensive and defensive features of the first-class battleships, and reducing the speed and power and the coal to be carried on trial to the amount necessary, in order that the trial displacement of 13,000 tons may not be exceeded."

To this decision Rear-Admiral Melville, Engineer-in-Chief, while signing the board's report of plans, took some exception. "While these vessels will undoubtedly be quite efficient," he wrote, "they would in my opinion be very much more so if given more speed, since I do not consider that a very heavy battery, comparatively low-sized and small coal capacity, with only nine inches of side armor, make the best possible combination. The displacement being limited to 13,000 tons makes it difficult, if not impossible, to produce a thoroughly satisfactory and up-to-date battleship."

Each vessel will have a battery of four 12-inch, eight 8-inch, ten 7-inch, and twelve 3-inch breech-loading rifles, and twenty other smaller guns. The armor protection will consist of a water-line belt of 9 inches, tapering to 7 inches at the bottom and to 7.5 and 4 inches at the ends, 7-inch casemate athwartship armor, 12 inches and 8 inches on the main turrets, 10, 7 1-2, and 6 inches on the main barbettes, and 9 inches on the conning tower.

In explanation of the principal features of the *Idaho* and the *Mississippi*, the board compares these vessels with those of the *Connecticut* class, which are to be 16,000-ton battleships. They will have, as regards armament, the same main battery, excepting only a reduction in the number of 7-inch guns from twelve to ten. Owing to the reduction in length from 450 feet to 375 feet, the secondary battery is somewhat less than the *Connecticut's*, the principal differences being in the reduction from twenty to twelve 3-inch and twelve to six 3-pounder guns. Part of the reduction in the secondary battery is due to the fact that in order to secure the heavy main battery and corresponding section of a first-class battleship it is necessary to omit the after military mast and to reduce the freeboard aft, as on the *Maine* class. It is accordingly not intended to fit these vessels as flagships.

The weight given to armor protection will be 3,377 tons, or 25.9 per cent. of the trial displacement, as against 3,992 tons and 24.9 per cent. for the *Connecticut*. The horse power of the main engines will be 10,000 against 16,500. The board is of the opinion that in working out the final designs this power will provide a maximum trial speed of 17 knots. Although the full coal capacity will be about 1,750 tons, as against 2,200 in the case of the *Connecticut*, its endurance is estimated at about 5,750 knots, as against about 5,300 for the *Connecticut*, at ten knots under ordinary conditions.

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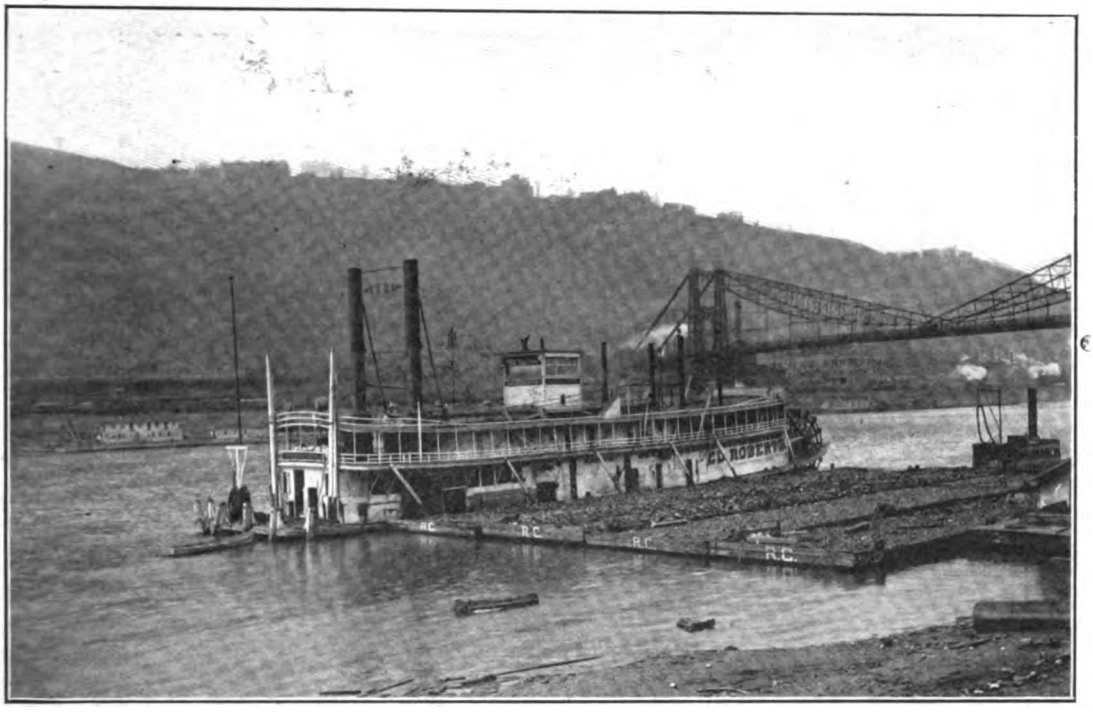
Towboats on Western Rivers.

The modern Western river towboat, such as is built on the Ohio and Mississippi, handles more tonnage and draws less water, it is claimed, than any other boat in the world. Here, in a single shipment, a towboat of about 175 feet in length will handle 50,000 tons of coal in barges down the Mississippi. The coal is mined in the hills of western Pennsylvania and carried to the markets of Cincinnati, Louisville, Memphis, and New Orleans. The Monongahela River Consolidated Coal and Coke Company, which controls the shipment of river coal from Pittsburg, and which owns between 75 and 80 steamers, as well as 20 to 30 tugs, transports each year no less than 150,000,000 bushels of coal.

fleets were favored with high water and no less than 50 towboats started down from Pittsburg, their fleets aggregating 10,000,000 bushels of coal. The fleets made up at Pittsburg consist of 10 to 20 craft, coalboats and barges, and one or two fuel flats for supplying the towboat with fuel. When the large boats reach Cincinnati and Louisville the size of the tows is doubled. On the return trip on the Ohio the towboats bring back from 20 to 25 empties, making from 3 1-2 to 4 miles an hour upstream. The downstream speed with the current is from 5 to 6 miles, but the speed, both up and down stream, is dependent upon the water in the river. If the water is at low stage the speed must be slow, to avoid accident.



OHIO RIVER STEAMER ED. ROBERTS AND COAL BARGES AT PITTSBURG.

The steamers of this company are divided into four classes. In the first are those plying between Pittsburg or Louisville and New Orleans, the former course being not less than 2,000 miles; the second class of steamers take coal only as far south as Louisville; the third class tow the barges down as far as Cincinnati; while the fourth class comprise the smallest steamers, used in bringing the tows from the loading points on the Monongahela river to Pittsburg harbor, where they are prepared for shipment to the South.

Some of the vessels of the present fleet have been in active service for more than thirty years, and navigating these streams requires most skilled piloting. The compass is not used, the pilots steering their boats according to sights on the shore, and run by day and night.

As the rivermen have to depend entirely upon freshets to start the coal shipments from the Pittsburg district, the boating season only lasts from six to seven months, starting in the late fall and lasting until early summer. During the first week of July of the present year the

At some points in the rivers the steamers steer their fleet by reversing, in order to clear a bend safely or avoid shoals or sand bars. It is this requirement which doubtless has developed the stern-wheel type of boat, which is found altogether on these rivers.

The engines are placed aft and are two in number, one on either side, each working through a long pitman or connecting rod to a crank at each end of the shaft. They are either compound condensing engines or high-pressure non-condensing, the latter being the usual type. Steam is supplied from long, cylindrical flue boilers placed forward. The horse power of the largest boats is about 2,500, while the smaller ones have proportionately less power.

The towboats of the largest class handle from 30 to 40 pieces or barges, containing a thousand tons each, below the falls at Louisville, while above this point the narrow channels and bends, and also the narrow bridge spans, will not permit of handling so large a fleet. The usual length of trip from Pittsburg to Louisville is

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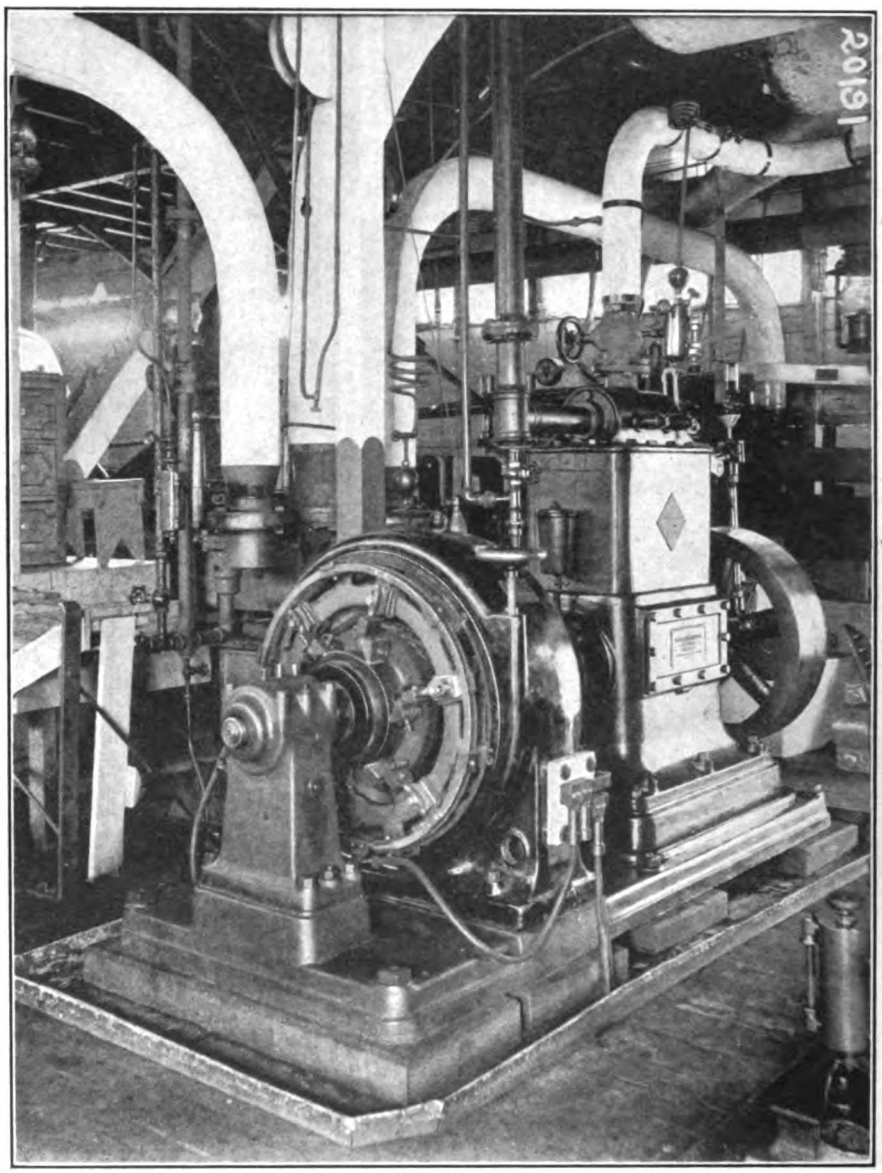
6 to 8 days and from Pittsburg to New Orleans about 30 days; the time, as above stated, depending upon the condition of the water and also the weather. The large river steamers burn from 1,500 to 2,200 bushels of coal every 24 hours when under way.

Of the towboats that ply between Pittsburg and Louisville, the *Ed. Roberts*, here illustrated, is a typical boat. She is 171 feet long, 32.5 feet beam, draws 5.5 feet of water. There are two high-pressure engines, the cylinders being 22 inches diameter by 7 feet stroke. Steam is supplied by 5 boilers, 40 inches diameter by 25 feet long. The *Roberts* was built at Madison, Ind., in 1884. Next to the new steamer *Sprague*, the *Joseph B. Williams* has handled the largest fleets on the river, the coal in a single fleet amounting to 50,000 tons. As this boat has already been described in Marine Engineering, her dimensions only will be given, viz.: length, 210 feet; beam, 40 feet; depth, 6.5 feet.

Another boat is the *Defender*, built in Pittsburg in 1881. She is 177 feet long by 41 feet beam by 7.3 feet deep; her tonnage is 514. The cylinders of the high-pressure engines are 24 inches diameter by 9 feet stroke; 6 boilers are installed, carrying steam at 181 pounds. This boat is in the New Orleans trade, and 11 other vessels, belonging to the same company, are similar in size and construction. Of the other steamers owned by the company, 24 are operated in the pools of the Monongahela, 25 run between Pittsburg and Brownsville, 12 are harbor boats for use at Cincinnati, Louisville, Cairo, and Dekoven, Ky. There are also tugs owned by the company operated at New Orleans.



DECK VIEW ON OHIO RIVER STEAMER, SHOWING WESTINGHOUSE DIRECT-CONNECTED ELECTRIC-LIGHTING SET.

Of the pool boats, or jobbing boats, the *Harry P. Jones* is a fair example. Steamers of this class are only used for towing coal out of the pools or harbors to make up the fleets which are sent South. This boat

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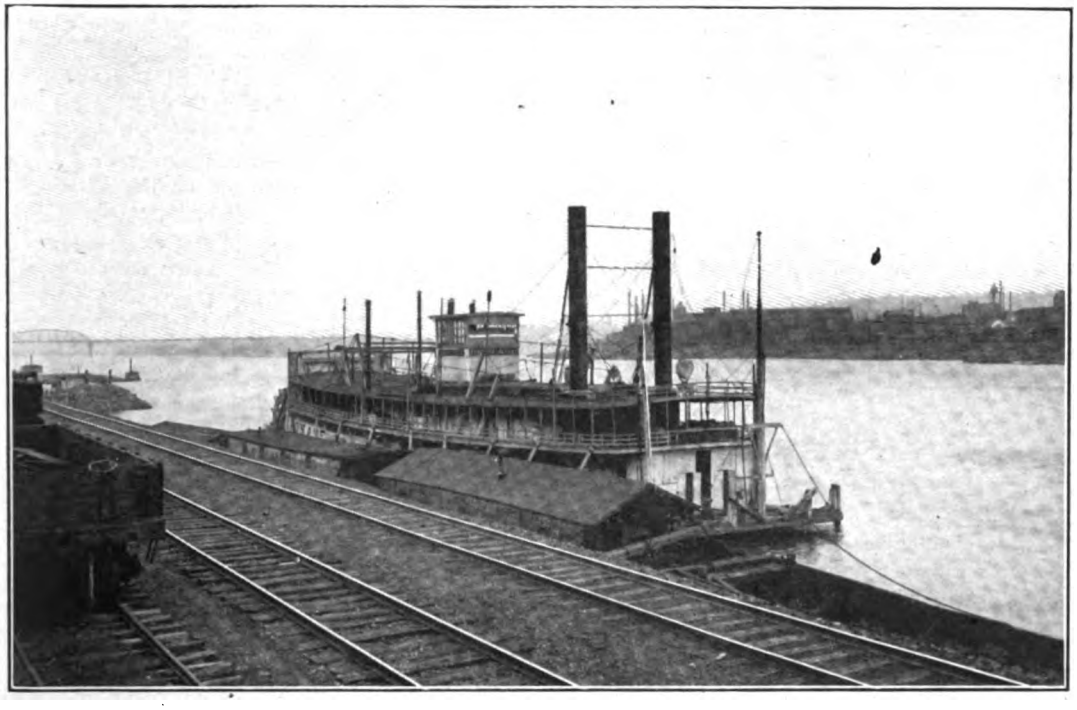
is 116 feet long, 22 feet beam, 4.5 deep, and draws about 3.5 feet of water. Her engines have cylinders 16 inches diameter and 4 1-2 feet stroke. There are but three boilers installed. This boat can handle 10 or 12 barges, containing 6,000 to 7,000 tons.

Nine of the vessels of this company are equipped with Westinghouse electric-lighting sets, from 15 to 30 kilowatts capacity each; some are direct-connected, while others are belted.

Cunard Liners.—While the authoritative announcement has not been made, it is generally understood that the Cunard Company has awarded contracts for the two new express steamers to Messrs. C. S. Swan and Hunter and to John Brown and Company, Ltd. As originally drawn the required maintained sea speed prevented builders from submitting bids.



OHIO RIVER STEAMER IRON AGE, USED IN TOWING THE COAL FLEETS ON THE OHIO.

ON SCREW SHAFTS.*

BY JOHN LIST, M. INST. C. E.

Increased size and power in merchant steamers has led to the more general adoption of twin screws, while at the same time there has been a distinct tendency toward comparatively full models, giving good carrying capacity on a moderate draft. This fulness of form has led naturally to the bossing out of the hull to house the stern tubes and shafts in place of fitting outside brackets, although the latter are retained in warships and other vessels of specially fine form. Where bossing out is adopted, the stern tubes and propeller shafts are usually similar in all respects to those fitted in a single-screw ship, and the shafts can be drawn inboard for examination without difficulty. Where, in very fine-lined ships, brackets are fitted with long, unprotected shafts outside the hull, it is necessary in many cases to draw the shafts outboard, which involves couplings removable from the shafts, thus introducing some mechanical difficulties, especially in the case of large and heavy shafts.

Where the usual form of stern tube is fitted, the shaft may be covered with gun metal throughout its length, which gets over, to a great extent, the risk of corrosion and consequent weakening of the shaft.

In recent years the changing conditions of trade (with the United States particularly) have led to cargo steamers being sent long voyages in ballast. In the case of single-screw ships in this condition, the propellers are usually only partially immersed, with the result that the consequent severe racing has led in many cases to broken shafts. So great has been the loss from this cause that the registry societies have found it necessary to modify their rules in the direction of increasing the size of the shafting.

The diagram (in the original paper only) shows a typical case of a defective shaft. This was made of ingot steel by a Sheffield firm, to Board of Trade tests. It was removed on survey, after having run about 743,000 miles. The point marked "B" at the forward end of the after liner had been lapped with marline to prevent grooving at the end of the gun metal, and that part had not wasted at all, whereas at "C," immediately in front of the lapping, the reduction in diameter was quite 9-16 inch, and the surface of the steel at that part was cracked all round, as shown in the developed view. The depth of the cracks appeared to be about 3-8 inch. In this case the stern bush was not worn down, nor was the shaft at all out of line. When disconnecting the shaft it was found to be strongly magnetic; that, however, is

*Paper read at the Engineering Conference of the Institution of Civil Engineers, Section V. *Shipbuilding*, June 18, 1903.

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not uncommon in shafts which have been many years at work.

Where vessels are working in muddy or sandy waters the lignum-vitæ bearings of the stern tube are found to wear rapidly, and this has led to modifications where the bare steel or iron shaft runs on white metal, and is lubricated by oil which is fed into the stern tube by a pump driven by a cam on the tunnel shafting. To prevent access of sand or grit to the stern bush a metallic adjustable packing is fitted as shown in the diagram. The bronze spiral springs in this packing keep the rubbing faces in contact under a light pressure, and allow for the slight increase in length of the shafting due to the working temperature of the bearings and the heat of the tunnel. Steamers trading in the comparatively shallow waters of the Baltic ports are fitted much in the same way as that described.

Corrosion close to the face of the propeller boss, at the end of the gun-metal liner, used to be a fruitful source of failure of propeller shafts. This is now obviated by different forms of water stop. In these a ring of india rubber is squeezed against the surfaces so as to prevent access of sea water to the steel or iron. It is found that india rubber applied in this way and immersed in sea water will remain in good condition for several years.

The question of the life of steamship shafting is one of considerable importance, and it is no doubt desirable that shafts and other important working parts should be renewed, as in the case of locomotive crank shafts, after running a given mileage. Competition in ocean carrying is, however, severe, the conditions of trade are constantly changing, and ships become obsolete or unprofitable for the trade they were built for, and pass into other hands, so that renewals are not, as a rule, carried out unless defects incur rejection on survey by the Board of Trade or the registry societies. The practice, which is now becoming general, of building cargo steamers with one or more hold ballast tanks in addition to their double-bottom ballast capacity, will, by giving greater immersion to the propellers in the light condition, tend to reduce the risk of broken propeller shafts.

Shafts of moderate size are in some cases forged from selected scrap iron, but the amount of really good scrap in the market is small, and shafting for high-power ships is now generally forged from ingot steel. In first-class work about 40 per cent. of the top end of the ingot and about 5 per cent. of the total weight of the ingot from the bottom should be rejected in the forging. It is also, in some cases, specified that the sectional area of the finished forging is not to exceed one-sixth of the original sectional area of the ingot. It may safely be affirmed, however, that for the ordinary run of steel shafting for merchant steamers considerably smaller ingots, in proportion to the finished forgings, are used.

While for high-power cruisers propeller shafts of, say, 24 inches diameter are fitted, having the internal diameter about 75 per cent. of the external, it is not usual in full-power passenger ships to find such extreme proportions adopted. In the case of the Atlantic passenger ship *Deutschland* the particulars published give the external diameter of the propeller shafts as 25.2 inches, with an internal diameter of 10 inches. The conditions are, however, different. In the case of warships an excessive maximum power on the minimum weight is essential, and the question of first cost must be entirely subordinated to the attainment of that result, whilst at the same time the vessel generally steams at low power. Also the fineness of form necessitates very long outboard shafts with bearings far apart. In the case of the passenger ship the maximum seagoing power is continuously exerted and the shafts are carried in stern tubes housed in the bossing, and with long bearings spaced close together. For the hard and continuous work of the Atlantic high-speed service the arrangement adopted is that best suited to the requirements; but it is not applicable to a warship, where the extreme proportion of beam to length necessitates an entirely different form of model and arrangement of shafting.

Nickel-steel shafting has been largely adopted, not only in full-power ships on the Atlantic, but also in the shafting of many foreign warships. The crank shafts, thrust and propeller shafts of the *Deutschland,* before referred to, are of nickel steel, and in the later and still higher power ships of that class the same material is used. The ultimate tenacity of some heavy shafting forgings of nickel steel made on the Continent is 38 to 40 tons per square inch, with about 20 per cent. elongation, and a ratio of elastic to ultimate stress of about 67 per cent. Rather softer steel made in this country, and showing 3 to 4 per cent. of nickel on analysis, has been extensively used for shafting, so far with satisfactory results. Its ultimate tenacity is 36 to 38 tons per square inch, with about 30 per cent. elongation on 2 inches, and an elastic limit of 60 per cent. Such steel will bend cold. For warship-machinery forgings, carbon steel of high tensile strength has been used, having an ultimate tenacity of about 35 tons per square inch, with about 32 per cent. elongation on 2 inches, and an elastic limit of about 65 per cent.

DISCUSSION.

Mr. John Sampson said that Mr. List had raised the question of the amount of metal on the top and bottom of an ingot, which he had said was 40 per cent. and 5 per cent. respectively of the total. His company hoped soon to make ingots where 10 per cent. would be sufficient, as they were introducing a French process for compressing the steel during the casting of the ingot. With regard to tail shafts, it had often occurred to him that in view of the number of breakages, and the frequency of repairs, the cost of demurrage, loss of time, salvage, etc., it would pay the shipowner handsomely to increase the size of the shaft by as much as 40 per cent.

Mr. Harding said he thought the question of the racing of screw shafts might be more affected by reducing the weight of the propeller, which acted as a flywheel, than by increasing its diameter, and as a dividend earner the bronze propeller would pay very much better than heavy cast-iron or cast-steel screws. As to the annealing of tail shafts, he said that with mild steel it has been accepted as the correct practice to anneal after fire-working, but an exception was made of tail shafting. Mr. Harding thought the cracks in the shaft, which Mr. List specially referred to in his paper and illustrated by diagrams, were probably due to the

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blow of the hammer in forging, not affecting the steel right into the heart of the ingot. He preferred lignum vitæ for bearings; it wore twenty or thirty times better when set with the end of the grain against the shaft than was the case in the old system of using it with the grain. In his experience amongst coral islands, lignum vitæ proved very much better than white metal. It involved fewer repairs. Nickel steel seemed to have great virtues when it was good; but he gave results to show that it was not always reliable, owing, he thought, to the fact that the nickel was apt to segregate at one or other end of the ingot; it was not always homogeneous. Moreover, the presence of nickel in the steel led to an increased corrosive effect of the steel in its vicinity. Nickel steel tubes in boilers would have a deleterious effect on mild steel plating.

Mr. R. T. Napier called attention to the great importance of making the tunnels strong, and of carrying the bearings well down to the structure of the ship, as this insured true aligning of the shaft. Many fractures were due to the shaft getting out of alignment.

Mr. William H. Ellis, of the Atlas Works, Sheffield, said that a head of 40 per cent. at the top of the ingot had been quoted as desirable, and this was put before steel makers as though it were going to keep them in order, but no policeman of this description would have that effect. Such a stipulation would not insure good steel, unless the manufacturer himself was determined that his work was to be sound from top to bottom; and there would be no difficulty in arriving at that result, even with ingots where only 25 per cent. was left to be cut off. Proper precautions must be taken in all cases apart from the head. It was not only a question of soundness that was concerned; soundness began before lack of uniformity left off, and this want of homogeneity was an important matter. Again, the question of relative area was always being forced on the steel maker; but this also could be overdone, and in his own recent work he had obtained far better results from Admiralty shafting, where the size of the ingot had been cut down well within the 6 to 1 limit, the reason being that the larger the ingot the greater the variation between the center and the outside; and it was this want of uniformity of structure that the steel maker had specially to guard against. He would like also to impress upon engineers the advisability of avoiding as far as possible the forging of shafts in such a way that half the shaft was forged in one direction and the other half in the opposite direction, after turning the shaft round. This caused a lack of homogeneity at the point where the forging in different directions met; in fact, it was almost necessary that a portion of the shaft, adjacent to the portion being forged, should be heated to the forging temperature and left without sufficient work being put upon it. As to iron shafts, the point to be kept in mind was the fact that in making them everything depended upon the forgeman. Many shafts had been brought to his notice which had had to be broken up for the reason that they had failed owing to the carelessness of the forgeman in not having obtained satisfactory welding heats. On the other hand, in the case of steel shafts it was necessary to insure a good quality of steel in the ingot, and an ingot properly produced to insure good homogeneity; and given that the forgeman obtained such an ingot, it was a comparatively simple matter for him to observe the necessary precaution to insure a satisfactory forging.

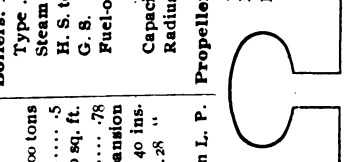
People were inclined to regard nickel steel as if it were ordinary steel; but, where introduced, it must have its own special treatment, because, if treated in the same way as ordinary steel, the results could not be satisfactory. He thought that treatment such as oil hardening and annealing was absolutely necessary for nickel steel. As to the question of test pieces, incidentally raised by Mr. Harding, he might state that on that very day the Standardization Committee were endeavoring to arrive at a standard in which the elongation would be relative to the area of the specimen. The question of elastic limit was not yet settled, and it was extremely difficult to register. Otherwise, they would probably see the ultimate strain discarded, and would use the elastic limit as the correct standard.

Mr. H. H. West said that Mr. List had referred to the bossing-out of the hull to house the shaft, but he thought that for high-speed steamers the old-fashioned A bracket affected speed less, although it did not afford such a rigid support for the larger shafts. Mr. West had had experience of a case where the boss was bored out in place during the construction, while the bossing was supported on shores which were very hard set. When these shores were removed the shaft was distinctly out of line, and he quoted a case where the extent was 7 1-4 inches. When the change in alignment was sudden, the evil was distinctly greater.

NAME—Dauntless. **NATIONALITY**—American. **TYPE**—Ocean-going tug.

LAUNCHED—1903. **BUILDER**—Risdon Iron Works. **OWNER**—J. D. Spreckels and Bros.

Length over all	128 ft.
" between perps	121 " 6 1-4 ins.
Breadth, molded	24 " 6 "
Depth, "	15 "
Draft, load	12 "
Displacement, load draft	500 tons
Block coeff	.5
Area midship section load draft	230 sq. ft.
Midship section coeff. " "	.78
Engines: Number	1 three-cyl. triple-expansion
Cylinder diams	15, 24 1-2, 40 ins.
Stroke	28 "
Valves	pistons on H. P. and I. P.; double ported slide on L. P.
I. H. P., estimated	750
R. P. M. "	120
Speed "	12 knots
Built-up crank shaft diam	8 3-4 ins.
Tail shaft	9 1-4 "
Condens. surf	1,230 sq. ft
Boilers: Number	2
Type	Babcock and Wilcox
Steam pressure	220 lbs.
H. S. total	3,000 sq. ft.
G. S. "	75 " "
Fuel-oil system	either compressed air or steam atomizer
Capacity of tanks	1,211 barrels
Radius of action	5,500 miles
Propeller	cast iron, 4 blades,
Diam	10 ft.
Pitch	13 " 6 ins.
Developed area	43 sq. ft.



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OCEAN-GOING, OIL-BURNING TUG DAUNTLESS.

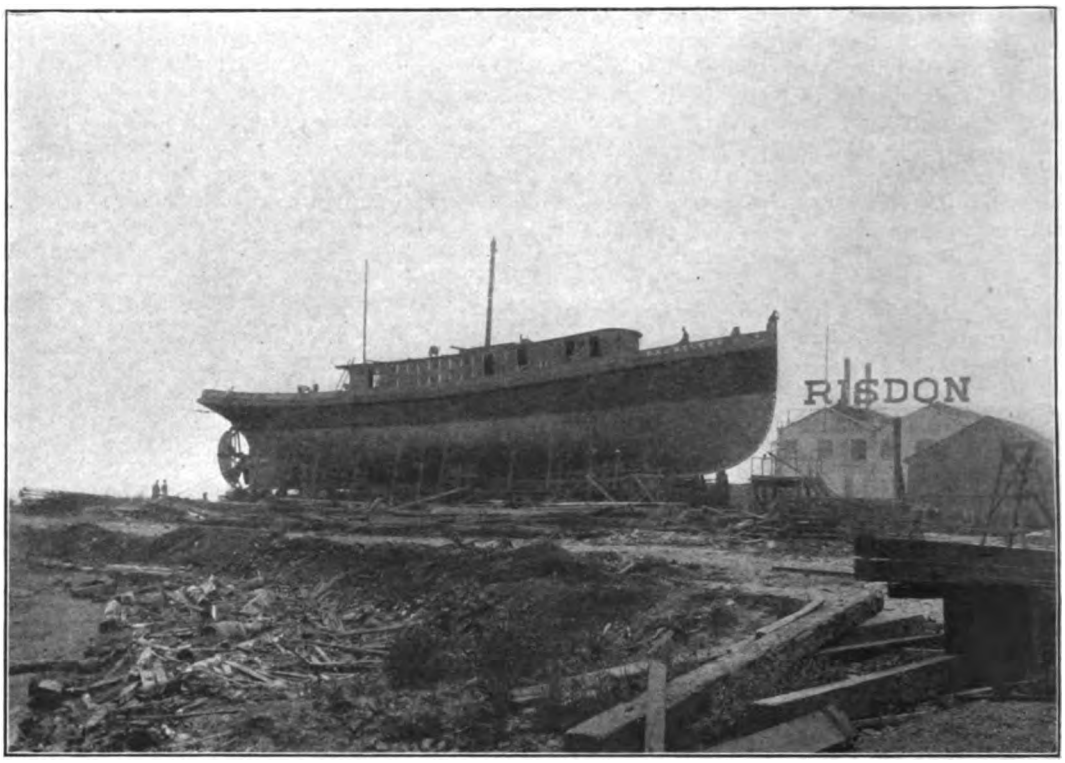
On the evening of May 5 there was launched from the shipyard of the Risdon Iron Works, San Francisco, the hull of a new oil-burning, ocean-going tug, *Dauntless*, which when completed will probably represent the highest type of development along these lines. This vessel is being built for J. D. Spreckels and Brothers Company, of San Francisco. It will comply with the highest class (100 A) of Lloyd's requirements, and in many respects is considered in excess of the rules, particularly with reference to cellular double bottom, bulkheads, and equipment.

Open-hearth steel is used throughout, including deck, deck-house erections, and companionways. The transverse bulkheads, extending the whole width of ship, are five in number, and where necessary are fitted with water-tight doors. At the sides of the boiler space there are fitted two oil-tight longitudinal bulkheads. Oil is to be used for fuel in the boilers, the oil being carried in tanks which form part of the structure of the ship. There are eleven fuel tanks in all, one tank being in the double bottom forward of the boiler space, three tanks in double bottom under the boiler, three tanks on each side of same, and one tank in the space under the engines.

This minute subdivision has many advantages. Apart from being exceedingly beneficial in stiffening the hull structure, the ship is at all times under perfect control as regards trim, both longitudinally and transversely, and she is also rendered practically invulnerable against collision or grounding.

The comfort of the officers and crew has been well considered. The steel deck house is about 60 feet long by 12 feet wide by 7 feet high. At the forward end of this house is an entrance to the crew's quarters, which are large and commodious and located under the main deck forward. On the starboard side of this entrance is a lavatory and toilet. Aft of this are located the mess room and galley, then come the boiler casings, and at after end of house is the upper engine room, in a corner of which is an additional toilet entered from the outside. Fourteen-inch air ports give this deck house ample light and air, and in addition to these there are gratings over the boilers and a skylight over the engines.

Immediately aft of the engine room, under the main deck, are the quarters of the engineers and mate, also a spare state room. Aft of the officers' quarters is the hawser locker. On the roof of the deck house the pilot house and captain's quarters are located, this house being built of pine with an elliptical front, and erected on a steel coaming. Wood has been eliminated to a great extent in the construction of this vessel, and the sides and ceilings are in most cases cork painted instead of being sheathed. In the extreme ends of the ship are the peak tanks, fitted for carrying the supply of fresh water.



OIL-BURNING SEA TUG DAUNTLESS BEFORE LAUNCHING FROM THE RISDON IRON WORKS.

Great care has been exercised in the plating and riveting of the vessel, this being absolutely essential on account of the numerous subdivisions, and the severe testing that had to be gone through with while the ship was on the stocks, to prove the oil-tightness of the tanks.

The vessel is fitted with two pole masts and has a complete set of sails, including a square sail on the foremast. A heavy derrick boom is also fitted to the foremast. Two 18-foot metallic lifeboats are included in the equipment, fitted with hinged, swinging davits.

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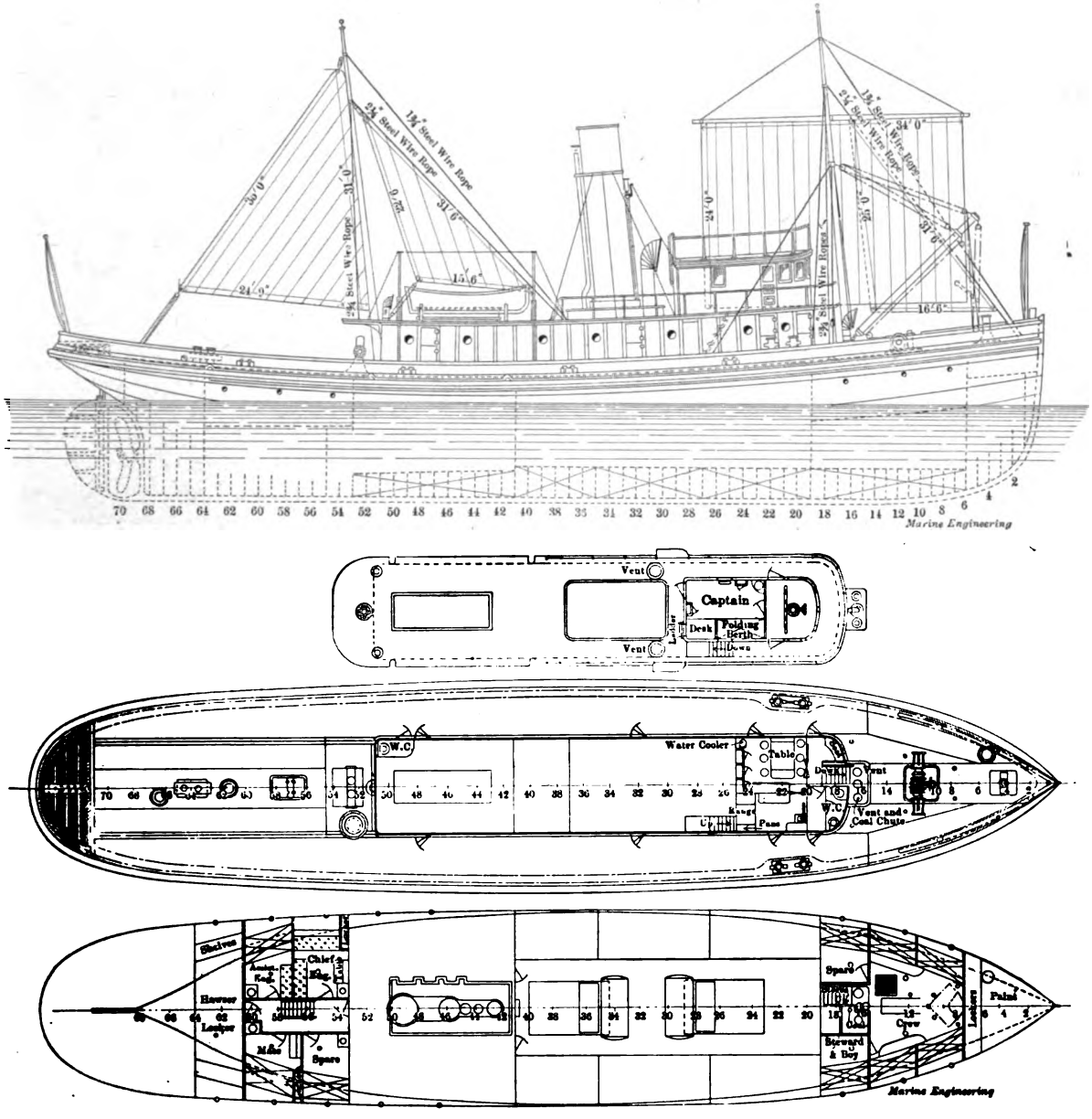
The oil tanks have a capacity of 1,211 barrels, thus giving the boat a fuel supply for about 20 days' continuous steaming. This gives a radius of action of over 5.500 knots at an economical rate of speed, demonstrating the superiority of crude oil as a means of fuel for marine boilers.

The dimensions of the machinery will be found in the accompanying table. The main engine is of the usual inverted, triple-expansion type, built for working pressure of 220 pounds. The pistons are of cast iron, box section; the crossheads are of the locomotive type, and the piston rods 3 7-8 inches diameter; the connecting rods are tapering, from 4 1-2 inches at the lower ends to 3 3-4 inches at the upper ends. Reversing is accomplished by 7-inch steam cylinder with floating links. The crank shaft is built in three interchangeable sections and all shafting is solid.

Steam is supplied by two Babcock and Wilcox water-tube boilers carrying steam pressure of 220 pounds per square inch. The boilers are placed in a fore-and-aft direction with one fire room between them; the uptakes lead into one funnel 5 feet in diameter.

The auxiliaries include two duplex vertical pumps, steam cylinder 6 inches, water cylinder 4 inches, and stroke 6 inches. The sanitary pump is duplex, 4 1-2, 3 3-4 by 4 inches; the bilge pump, 5 by 5 by 6 inches; the air pump is a twin-beam vertical compound with 5- and 10-inch steam cylinders, 14-inch air cylinder, all having common stroke of 10 inches; circulating water is supplied by a centrifugal pump. The donkey pump is duplex, 5 and 3 1-2 by 6 inches. The windlass is driven by a 6 by 8-inch engine and the steam capstan by a 5 by 7-inch double engine. Steam steering gear is fitted, the engine being 4 1-2 by 4 1-2. An electric light system is



SAIL AND DECK PLANS OF THE OCEAN-GOING TUG DAUNTLESS.

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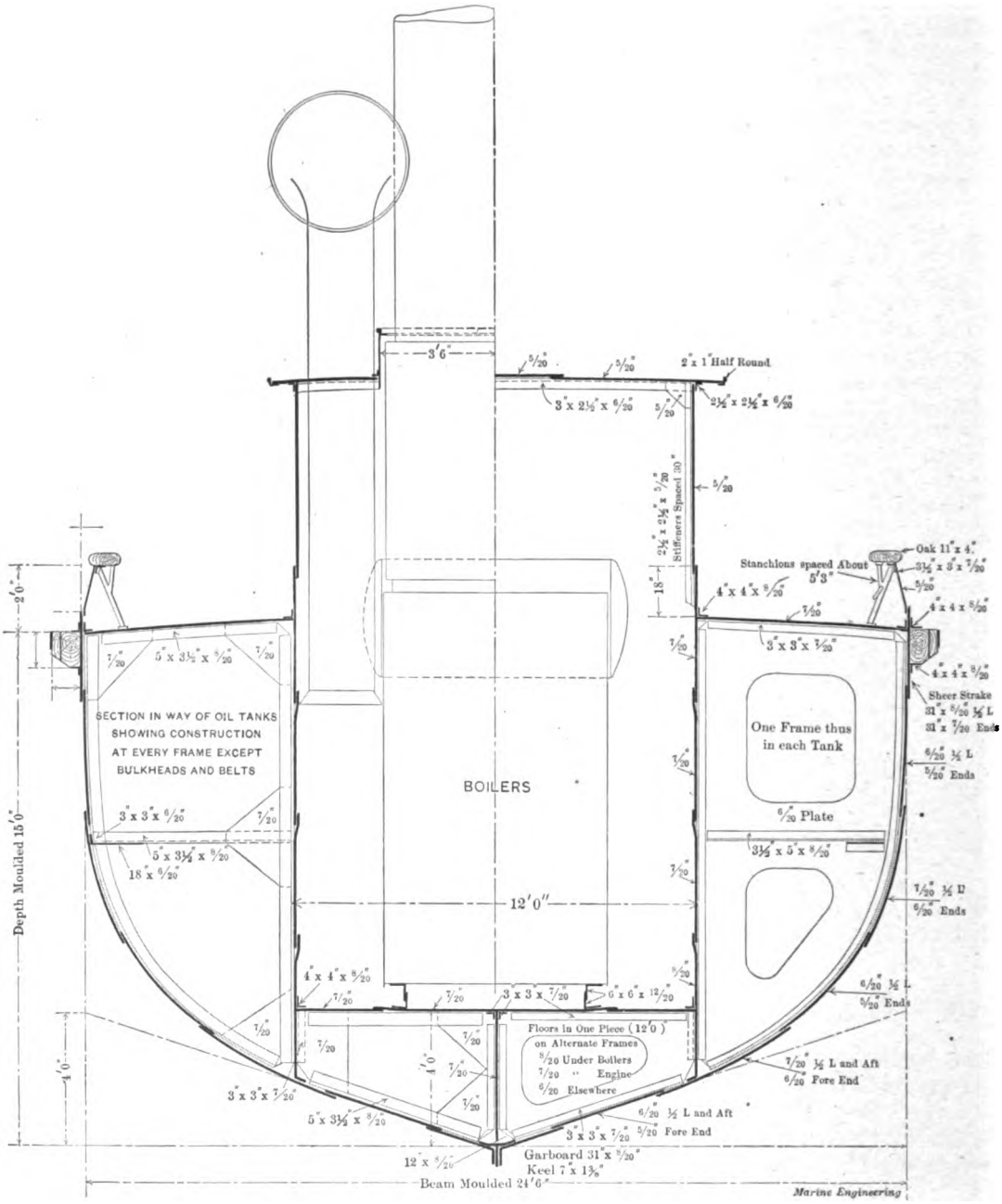
installed throughout the vessel and consists of a 6 K. W. generator, driven by a standard De Laval 10 horse-power steam turbine, direct-connected. The guaranteed steam consumption of this outfit, with steam at 150 pounds and a vacuum of 24 inches, is 28 pounds of dry steam per brake horse power per hour at full load, and 33 pounds at one-half load.

The fuel-oil system is similar to that used on the other Spreckels ships and is manufactured by Tucker and Grundell. The piping is so arranged that oil can be admitted from any one tank to any other tank in the ship, and for this purpose an oil trimming pump will be used, of the vertical duplex piston type, 5 by 5 inches by 6 inches stroke. Either oil or steam can be used for atomizing, and all the piping is so arranged that a change from one to the other can be made almost immediately. For furnishing air a double crank and fly-wheel compressor with an 8-inch steam cylinder and 12-inch air cylinder, both having stroke of 10 inches, is used. The oil pumps for delivering fuel to burners are two in number and of the same size as the sanitary pump, 4 1-2 by 3 3-4 inches by 4 inches. A Ross feed-water filter is used in connection with a pressure feed-water heater.



MIDSHIP SECTION OF THE TUG DAUNTLESS, BUILT AT THE RISDON IRON WORKS.

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CAVITATION WITH SCREW SHIPS.*

BY J. A. NORMAND.

The attention of marine engineers has recently been directed to a phenomenon which may become manifest in the operation of a screw propeller, especially at extreme speeds. Its importance, for a long time unsuspected, appears to exceed that of all other causes of losses in efficiency. In fact, according as it is produced, even partially, or not produced, the power necessary to attain a given maximum speed may vary in the ratio of 3 to 2, or even 2 to 1. If it should be produced completely, no increase of power, no matter how great, would produce any increase of speed.

This phenomenon, to which some nine years ago at the close of a series of experiments with boat stationary I gave the name "rupture of cylinders of water acted on," is now known under the simpler name of "cavitation." Following are the characteristic features of this phenomenon:

The velocity of water in the induction pipe of a centrifugal pump cannot exceed a certain value, which depends primarily on the effective head. When this head is zero the maximum theoretical velocity is that of water entering a vacuum under atmospheric pressure, which is about 46 feet per second. This velocity is, however, never reached, on account of the inevitable losses of effect. Should the velocity of rotation become raised beyond that for which the pressure of the water at the pump admission is equal to that of the vacuum, the entering column of water becomes ruptured and the work is expended in eddies and whirls.

In the same manner in the case of a ship, the water rushes toward the propeller in virtue of the pressure of the atmosphere, augmented by that due to the height of the water line above the point of the propeller under consideration. The cylinder of water thus drawn toward the propeller remains entire and continuous so long as the velocity with which it moves does not exceed a certain value. Beyond such value cavities are formed and the power is expended in eddies and whirls.

There exist, however, two very important differences between the pump and the propeller. The inflow passage of the latter is not closed, and, furthermore, the acceleration which the propeller impresses on the water is not uniform for the various parts of the cylinder of water acted on. It follows that the average velocity of inflow for which rupture is liable to be produced is much further removed from the theoretical value than in the case of the pump. It may be remarked incidentally that the action is quite different in a ventilator or in an air propeller, on account of the expansion of the air.

The quantity of motion or momentum impressed on the water by the propeller measures the resistance of the ship. If the velocity, which forms one of the factors of this quantity of motion, is so high that cavitation is produced, the natural remedy will be to augment the other factor, the mass of the liquid, which in turn is proportional to the surface of the propeller.

These considerations have led me to the following simple rule:

The propulsive surface should be proportional to the product of the resistant surface by the speed, or, more exactly, to the quotient of the power by the square of the speed.

This gives the following equation, of which the first member represents approximately the propulsive surface:

$$nd^2r^{\frac{5}{4}} = J\frac{F}{V^2}.$$

n = number of propellers supposed to be identical.
d = diameter of the propellers in feet.
r = ratio of total developed surface of one propeller to that of the circumscribed circle.
F = maximum indicated horse power.
V = speed in knots.
J = numerical coefficient.

Experience shows that the coefficient J, which should be greater as the fineness of the form relatively to the speed is less, should never be less than 6.5, and may, with advantage, even exceed 8.5.

During the past three years and more this rule has received numerous verifications. It has provided the explanation of both exceptionally high and exceptionally low values of propulsive efficiency, which an examination of the form of the ship would not have accounted for.

For example, in a foreign navy three identical cruisers of 14,300 tons displacement and 31,000 I. H. P. were tried with propellers similar in their various characteristics except as to the pitch. They furnished maximum speeds sensibly the same. The curve of propulsive efficiency, however, plotted on speeds, showed a marked fall at the highest speed, and showed that an increase in speed of one knot would have required an increase of power of 15,000 or 20,000 I. H. P. On the last of these ships the original propellers were replaced by others with considerably greater propulsive surface. An increase in speed of more than a knot was obtained, without any sensible increase in power, and without the abnormal drop in the curve of propulsive efficiency. Evidently cavitation was produced with the original propellers. This indeed might have been foreseen by the aid of the preceding formula, inasmuch as the coefficient J showed a value of about 4.6, while with the later propellers its value rose to 6.5.

Thus a simple replacement of propellers, of which the cost represents scarcely one-third of one per cent. of the total value of the ship, sufficed to furnish a result which would have cost at the least thirty times as much had it been obtained by an increase in the power and in the dimensions of the ship.

It may be thought strange that a phenomenon of such importance as cavitation should have remained for so long unknown. The chief causes of this fact are the following:

(1) For many years past speeds have been steadily on the increase; but notwithstanding this fact it has been too often assumed that the values of the proportion between the propulsive surface and the resisting surface of the ship which were formerly in use, and quite sufficient under early conditions, might still be employed; while in fact this ratio must vary with the maximum speed. In consequence of this the velocity of flow of water to the propeller has greatly increased in fast

*Translated from *Comptes-rendus*, seance du 27 Octobre, 1902.

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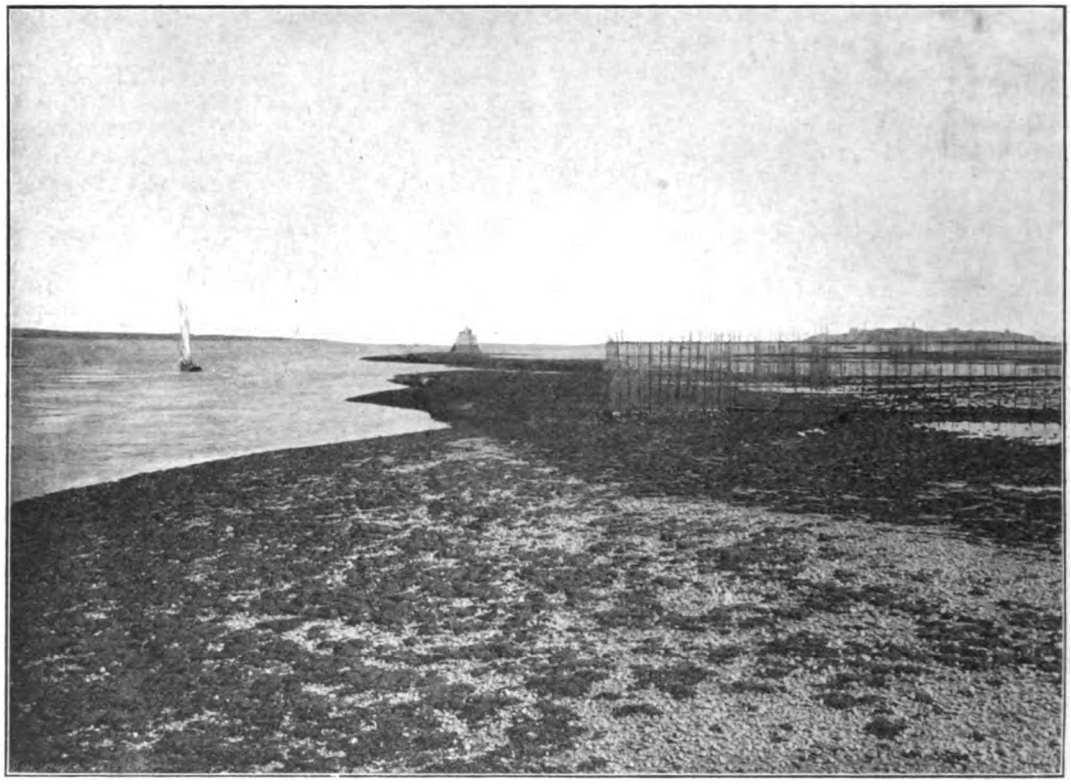
ships, and it is almost invariably with such that cavitation has been observed.

(2) Several eminent engineers, basing their deductions upon considerations which were quite exact in appearance, but which neglected the possibility of cavitation, then unknown, have assumed that the values of the slip commonly employed might be safely increased. Thus William Froude, to whom are due most valuable researches on waves and who justly enjoyed a high authority, said in 1878:

"Far from considering a large value of the slip as causing a loss of power, the opposite may be the case." He added: "A propulsive surface quite reduced in amount may be admitted without great loss of efficiency."

At that time the maximum speed of cruisers was about 18 knots. At the present time it is 24 knots and upward.

(3) It was at about this time that the first model-testing tanks were established. At the present time it is the rule in many navies to proceed with the execution of the design of a warship only after the model trials, which are made with the addition of propellers in order to approach as closely as possible to the conditions of service. It has been assumed that the laws of comparison were almost rigorously applicable, on condition that the speeds were proportional to the square roots of similar linear dimensions in the two cases. Such is indeed the case, except in so far as cavitation may enter, unless, indeed, the pressure of the atmosphere should be reduced in the proportion of the linear dimensions of the model and ship. The velocity of the water flowing to the propeller is produced, in fact, in virtue of the external pressure, increased by that due to the height of the water surface above the propellers. This last height is indeed proportional to the linear dimensions of the model, and would impress, if it acted alone, a velocity proportional to its square root; that is to say, to the corresponding speed of the model. But for the model experiment the pressure of the atmosphere is by far the more important element, and this remains constant in all such experiments. Model experiments with propellers, as they are now carried out, cannot, therefore, give direct evidence regarding the phenomenon of cavitation. It is therefore not permissible to attempt to deduce from such model experiments the results for the ship herself as regards this phenomenon. It must not, however, be concluded that such experiments are without value. On the contrary, they may furnish valuable indications, so long as they are not made of direct use in the determination of the dimensions of the propellers. For the latter, special rules should be employed.



VIEW ON THE BAY OF FUNDY AT LOW TIDE.

Many formulæ, based on experience, have been proposed for the calculation *a priori* of the speed of ships. If the propulsive surface of certain of these ships whose trials may have served to establish the formulæ was so small that cavitation may have been produced, it is probable that these formulæ are inexact at the extreme speeds.

Rear-Admiral Melville to Retire.—The Secretary of the Navy has appointed Captain Charles W. Rea to be Engineer-in-Chief of the Navy, to take the place of Rear-Admiral George W. Melville, who is soon to retire on account of the age limit. General satisfaction is felt throughout the Navy on the particular suitableness of this appointment.

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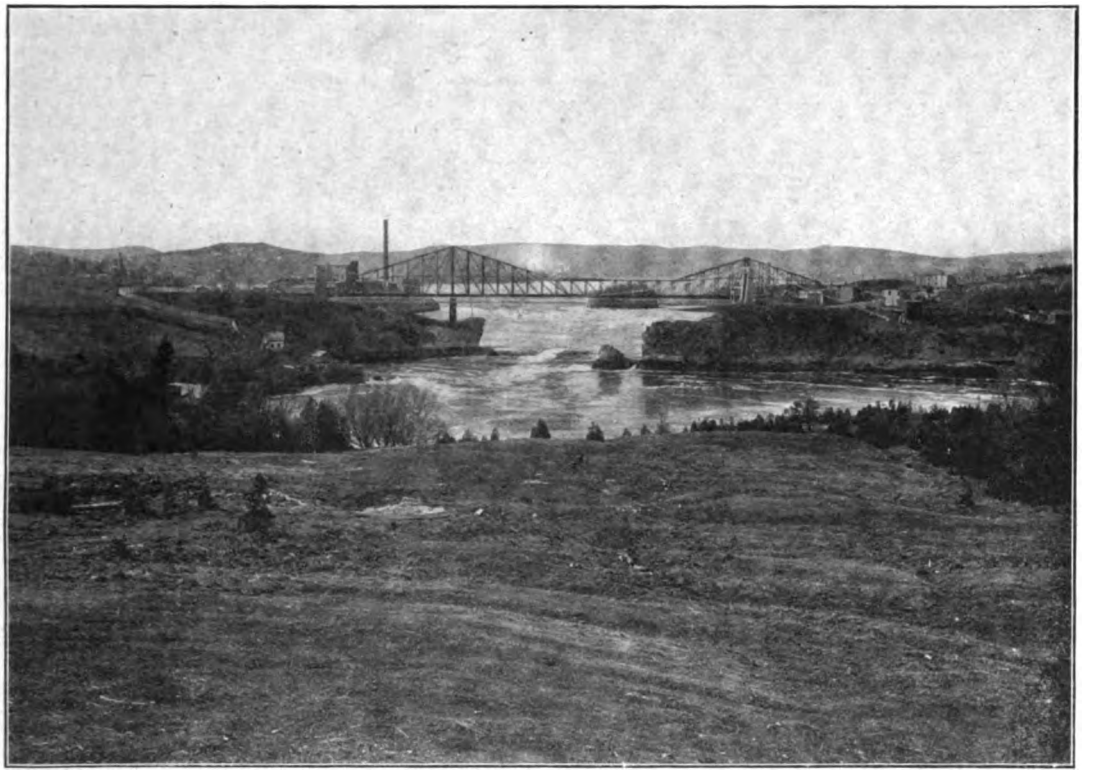
LARGE EBB AND FLOW IN HARBOR.

BY GEORGE H. WARING.

The harbor of St. John, N. B., Canada, being an inlet on the shore of the Bay of Fundy, causes it to partake of the large ebb and flow of tide for which that bay is noted. The maximum ebb and flow of the bay is 60 feet, and takes place at its head, and this harbor, being near its mouth, has an ebb and flow maximum of 28 to 30 feet and a minimum of 15 to 18 feet. The maximum flow occurs twice each month, coming gradually each tide from the minimum until the highest is reached, and then each ensuing tide is less until the minimum is again reached, the highest and lowest tides occurring when high water comes at midday or midnight, and the very fullest when the full moon comes at that time.



REVERSIBLE FALLS BETWEEN RIVER AND HARBOR AT ST. JOHN, N. B., THE TIDE FALLING.

It would be expected by those not acquainted with such large rise and fall of tide that there would be great difficulties to navigation presented, but experience has shown that is not so, and the handling and care of vessels in this harbor is not greater than in most of our North American harbors, and, in many cases and for some uses, the rise and fall is an advantage. While this rise and fall is so great, the main channel of the harbor has ample depth of water at the lowest ebb to float the largest steamers built; and for docking and loading them, what Nature has not done the city has—that is, constructed wharves or docks at which steamers can lie at all times afloat.

The smaller steamers and sailing vessels up to 200 tons generally are docked in slips which are entirely clear of water on the ebb tide. This has been found to be a perfectly satisfactory method of using that class of vessel, and it is no uncommon sight to see 30 or more of them lying comfortably on the ground. As almost all these vessels have considerable dead rise, the usual custom in mooring is to give them a slight list before they touch bottom on grounding, which careens them against the wharf at which they are lying. It is a very rare occurrence to have an accident or upset; in fact, it would be only carelessness or neglect that could cause it.

Advantage is taken of this high water for docking all classes of vessels and for repairs. At several places in the harbor timber gridirons are laid down on which vessels are floated to be left dry at ebb tide, during which time general repairs and painting or coppering are carried on, thus making a very cheap dry-dock. This method has been carried on for years; the men engaged at the work thoroughly understand the tides and do very satisfactory work. It is no uncommon sight to see one of our ocean steamers high and dry in one of the slips, having blades put on the propeller or other outside repairs or painting under way.

Advantage is also taken of the tide by ocean liners carrying cattle or horses, for, by catching the tide right, the animals may be driven on board, on spar or hurricane deck, across a level gangplank, a full cargo of cattle or horses being loaded in two hours.

A strange sight to many who visit this port is the tide running into St. John harbor from the Bay of Fundy, and, at the same time, the water in the harbor ebbing rapidly; in fact, the flow of water is inward until the tide has ebbed about seven feet. The reason for

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this remarkable condition, which is believed to exist in no other part of the world, is accounted for by the restricted outlet of the river which enters the upper end of the harbor.

The mouth of the river is through a narrow passage between two cliffs, as shown in the illustration on page 413. While the great ebb and flow occurring in the harbor amounts to 27 feet, the river is virtually non-tidal, its ebb and flow being only about 18 inches, as the waters of the bay are held back by the barrier above mentioned. The normal level of the river is about 7 feet below high level in the harbor; thus, on the flood tide, the water flows into the harbor, and when it has reached the level of the river, viz., 20 feet above low water, it flows through the barrier. The rush of water through the barrier increases steadily up to high water, when there is a head of 7 feet between the two levels. When ebb tide starts it will be seen that the water is flowing out of the harbor in both directions, viz., into the river and into the bay, the former gradually slacking off until the levels in the river and the harbor are the same; and, as the tide continues to ebb, the water in the river then flows into the harbor, the flow increasing steadily, so that by low water there is a head of no less than 20 feet in the falls at the mouth of the river. Thus there are reversible falls through this junction, and navigation, which is very large, has to be done when the level period occurs, which is four times every twenty-four hours, and lasts about twenty minutes each time.

MARKET SLIP AT ST. JOHN, N. B., SHOWING IMMENSE FALL OF TIDE.

Fiscal Year's Shipbuilding in the United States, July 2, 1903.

During the fiscal year ended June 30, 1903, the Bureau of Navigation states that 1,535 vessels, of 455,076 gross tons, were built in the United States and officially numbered, compared with 1,657 vessels, of 473,981 gross tons, for the previous fiscal year. Returns of vessels under construction on July 1, 1903, in the United States, indicate for the new fiscal year an output below that of the year just ended.

The world's shipbuilding reached its highest point in 1901. The diminished output since then has been less noticeable in the United States than abroad. Thus, Lloyd's latest returns show that on March 31, 1903, in the United Kingdom, 425 vessels of 974,685 tons were under construction, compared with 431 vessels of 1,240,344 tons for the same day in 1902.

The principal decrease in the United States for the past year has been in steel steamers built on the Great Lakes, which numbered 41 of 131,660 tons, compared with 52 of 161,797 tons for the fiscal year 1901-2. The only item of considerable increase has been the cheaper forms of construction—unrigged canal boats, barges, etc.—numbering 320 of 79,574 tons, compared with 297 of 57,502 tons for the previous year. Nearly two-thirds of the year's output consists of 92 vessels of over 1,000 tons each, aggregating 295,548 gross tons. Of these the Great Lakes' yards built 37 steel steamers, aggregating 130,283 gross tons, four of which, aggregating 7,147 tons, are built to pass through the Welland Canal for ocean coasting service. Three Lake steamers, *James*

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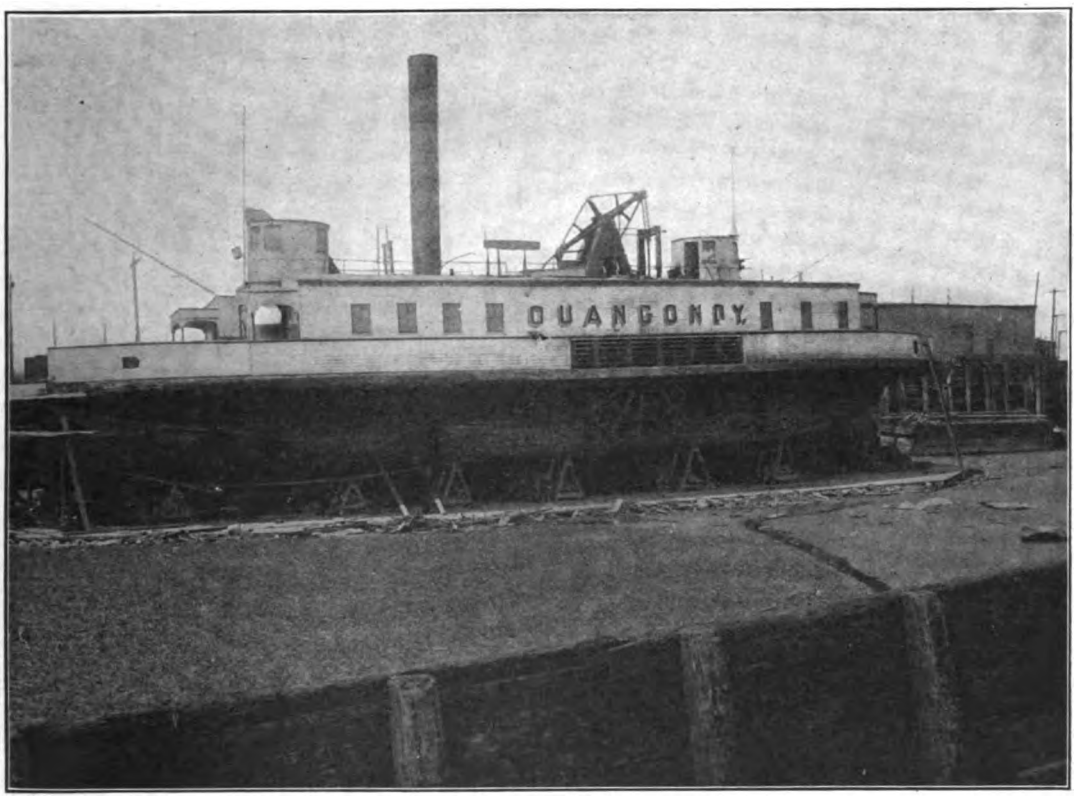
H. Reed, D. G. Kerr, and *D. M. Clemson,* each slightly exceeds 5,500 tons.

On the seaboard 18 ocean steel steamers, of 101,471 gross tons, were built, the largest output of this type in our history. The large vessels of this type contracted for in 1900 are now completed or will be completed, barring strikes or unforeseen delays, in the early spring and summer. No new contracts for this type have been made in two years. The year's additions were the *Finland,* of 12,760 tons—the largest vessel built in the United States this year—and the *Mississippi, Maine,* and *Massachusetts,* each of 7,913 tons, all four for the International Mercantile Marine Company; the *Siberia,* 11,284 tons, for the Hawaiian-Asiatic trade of the Pacific Mail, and the *Arizonian* and *Texan,* over 8,600 tons each, for the American-Hawaiian Company. Other steamers are for the coasting trade, of which 4 steamers, of 12,974 tons, carrying oil in bulk, are noteworthy.

Two barkentines for Pacific trade, aggregating 2,638 tons, were the additions to the square-rigged fleet. The new wooden schooners over 1,000 tons numbered 21, aggregating 36,537 tons. The steel schooner *Thomas W. Lawson,* of 5,218 tons, was documented early in the year. Other new vessels over 1,000 tons are 3 wooden steamers, aggregating 4,605 tons; 3 ferry and river steel steamboats, aggregating 3,849 tons; and 7 rigged barges of 10,947 tons.

United States Supervising Inspectors.—The Board of Supervising Inspectors of Steam Vessels has completed its session revising the Rules and Regulations, and will submit its recommendations to Secretary Cortelyou.



METHOD OF DRY-DOCKING ON THE BAY OF FUNDY. THE VESSEL IS FLOATED ON THE GRID AT HIGH TIDE AND AS THE TIDE RECEDES IS LEFT HIGH AND DRY.

EXPERIMENTS ON THE RESISTANCE OF A SCREW STEAMER IN FREE ROUTE.—I.*

BY H. ENNO VAN GELDER.

In a recent paper, on the resistance of ships in free route, read before the Ninth International Congress in Düsseldorf, Professor Oswald Flamm called special attention to the importance of the accurate determination of this resistance, whether through experiments on models or on full-sized ships. Experiments of the latter character are of the greater interest and value because the proper relation between the resistance of the model and that of the ship is not yet definitely known, and because further all such direct experiments which may be able to provide data on this subject are of the highest importance.

When an experiment is carried out on a model in which the latter is towed at a certain speed through the water, the resistance opposed to the motion is indeed measured, but this is not the resistance which would be met with were the model, like the ship, moved by its own propeller. This arises not alone because the propeller blades experience resistance in their movement through the water, but also because the propeller itself sets up a movement in the water in the immediate vicinity of the stern of the ship and thus produces an additional resistance to the forward movement of the ship.

These additional resistances can hardly be measured by model experiment, and are only to be satisfactorily

*Translated specially for MARINE ENGINEERING from *Schiffbau,* December 23, 1902, and January 8, 1903.

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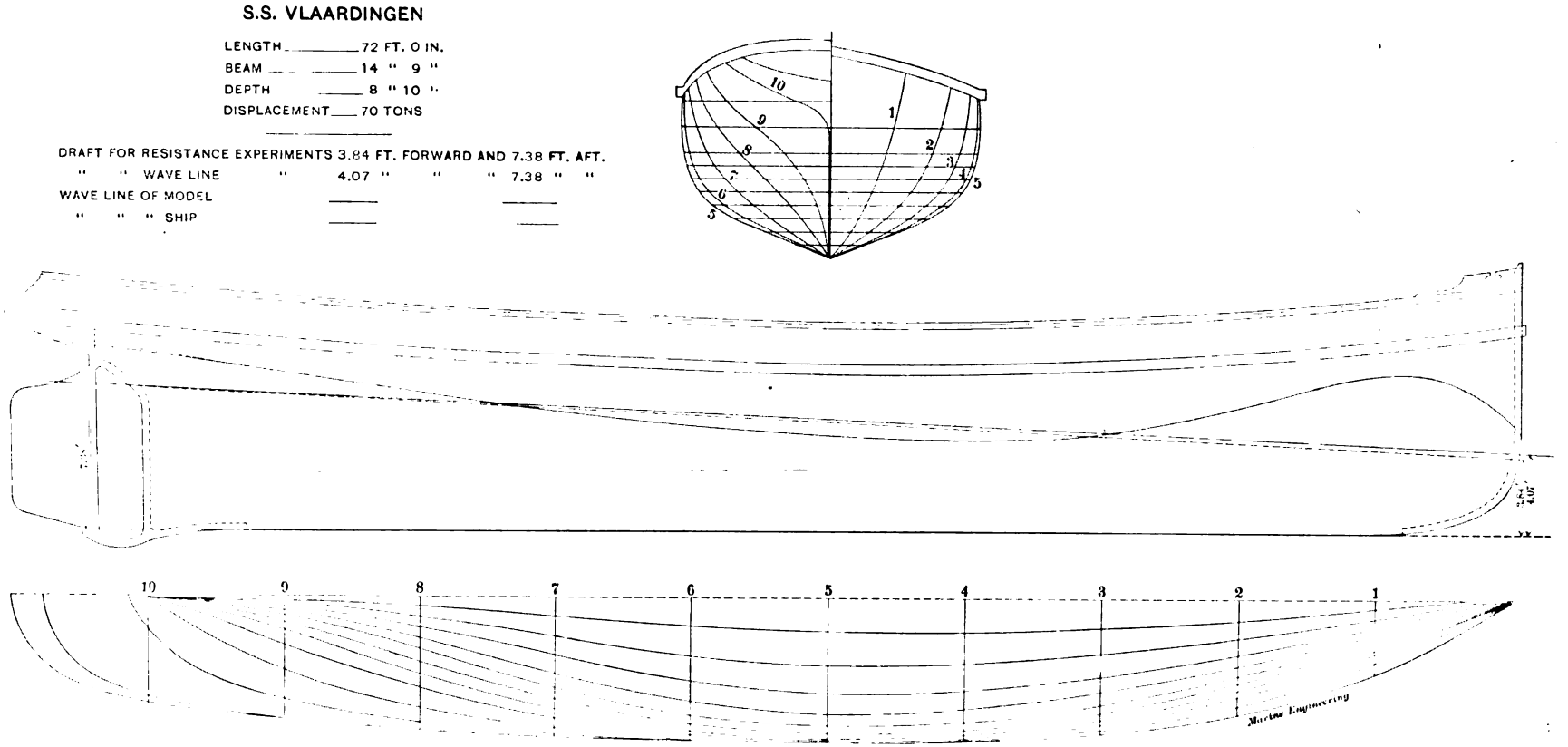

FIG. 1.

investigated through experiments on the ship itself. In the matter of model experiments the procedure is still substantially as follows:

The frictional resistance of the model is computed by empirical formula, and this is subtracted from the total measured resistance of the model. The remaining resistance is then transformed by the law of comparison into the resistance of the ship at a corresponding speed, assuming that the resistances of similar forms at corresponding speeds are in the ratio of the displacements.

Next, in a similar manner as for the model, the frictional resistance of the ship is computed by empirical formula, and this is added to that derived by the law of comparison, and the sum is taken as the total resistance of the ship at the given speed.

"Herein," notes Professor Flamm, "lies most certainly a definite uncertainty in the determination. The question properly arises whether, based on the observations of Froude regarding skin resistance, it is admissible to divide the automatically recorded total resistance of the model into these two parts, skin resistance and form resistance; further, whether it is admissible to add the skin resistance of the ship determined by formula to the form resistance determined by the law of comparison from the model. At the most it can be said that experience indicates that practically the total resistance of the ship is equivalent to that derived by model experiment at corresponding speed. This conclusion is, however, to a considerable extent based on a further empirical and unproven hypothesis. In order to make this clear it is necessary to show in further detail the method of computation. Suppose the case in which, through a model experiment, it has become possible to

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determine the resistance of a ship at a given speed, having reference as well to the operation of the screw propeller. Even so this will only furnish the *net* ship resistance. If this resistance be multiplied by the speed to which it corresponds there is thus obtained the net propeller power; that is, the work which must be developed at the surface of the propeller in order to force the ship through the water with the speed in question. This, however, is not the total work which must be developed by the engine, and even at the present time we are unable with assurance to relate the one to the other.

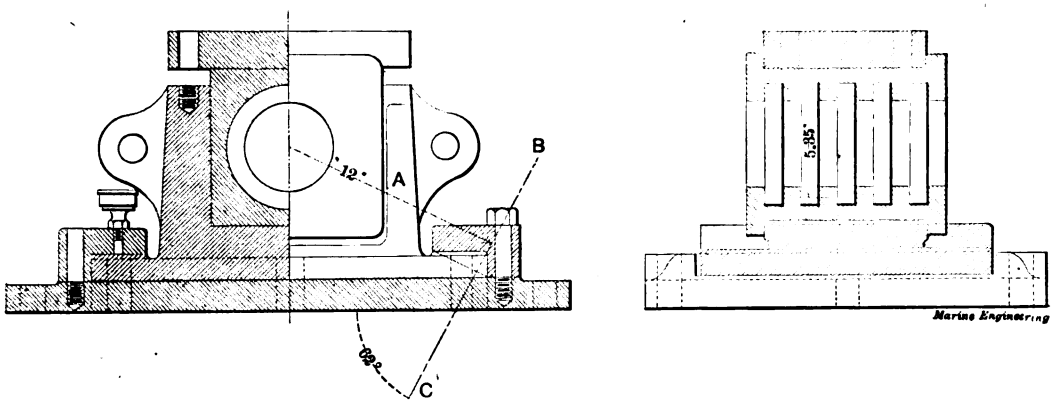

FIG. 2.

In earlier times, indeed, and especially in the first years of the steamship, many attempts were made, particularly in France and England, to accurately determine the mechanical efficiency of the marine engine, but without results of practical value. In consequence it became and yet remains customary to measure and to deal with

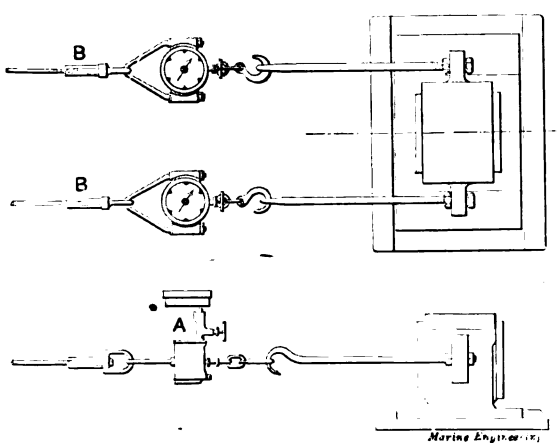

FIG. 3.

the indicated power of the engine; that is, with the total power developed in the cylinders. How much of this power is finally effectual and how much becomes lost on the way from the cylinders to the surface of the propeller, we have as yet no accurate means of determining."

It is therefore of the greatest importance to be able to accurately determine this loss of power in the transmission, and, to this end, two items may be sought, namely, the thrust power—that is, the actual power developed by the push at the thrust bearing—and the mechanical efficiency of the engine. The latter must be determined from the engine itself, or may, from the analogy with other available types, be assumed for the marine engine with reasonable accuracy. The thrust on the thrust block must in any case be measured on the ship, and to this end it is necessary that the thrust block be made movable—as, for example, by placing it on slides—so that the load which it carries may be measured by some appropriate form of dynamometer.

Such experiments are of the greatest value, and all marine constructors will learn gladly of the researches recently carried out by Herr Murk Lels, Director of the Kinderdyk shops near Rotterdam, relating to the resistance of a small screw steamer.

This steamer was the *Vlaardingen*, of which the lines are shown in Fig. 1, and of which the chief dimensions are as follows:

Length	72 feet
Beam	14 " 9 inches
Depth	8 " 10 "
Displacement	70 tons
Diameter H. P. cylinder	12 1-2 inches
" L. P. "	25 "
Stroke	18 "
Boiler pressure	100 pounds per square inch
Diameter of propeller	6 feet 3 inches
Pitch of propeller	7 " 7 1-2 "
Developed surface of propeller	15 square feet.

The purpose of these experiments was to measure the reaction of the pressure of the propeller on the water, and thus the actual resistance of the ship with reference to the work of the engine, all at a series of different speeds. To this end the direct load on the thrust block was measured, and this load multiplied by the corresponding speed gives the net power required to push the ship through the water at this speed. This is then compared with the work developed by the engine during the corresponding part of the trial.

To this end the thrust block (see Fig. 2) was made movable on a cast-iron sole plate, and was connected with two dynamometers for registering the load. The entire installation was somewhat similar to crosshead and guide, and the block was prevented from turning with the shaft by two gib pieces fitted as shown. The surfaces of the block, sole plate, and guides

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were very carefully made and were provided with oil grooves and means for lubrication in such manner as to reduce friction to the lowest amount. Computation showed also that the load on the ways was very small, amounting to only some 2 pounds per square inch. On both ends of the sole plate stops were cast, the distance between which was .32 inch greater than the length of the base of the thrust block. This clearance provided sufficient play for the proper control of the block by the dynamometers. In order that the shafting might be free to take up such movement, a longitudinal clearance of .36 inch was left at the main pillow blocks, and a like clearance between crank pins and connecting rods.

The dynamometers were two in number and of the Duckham type, consisting of a hydrostatic scale which measured the pressure by manometer, the general arrangement being shown in Fig. 3. These dynamometers were secured to each side of the block by means of lugs, as shown, and on the other side to a convenient part of the ship. To avoid the danger of an incorrect indication through the weight of the dynamometers, the latter were suitably hung from the deck beams. The observer whose duty it was to watch the dynamometers and record the load had also to watch the position of the thrust block, and, by the adjustment of suitable screws connected with the dynamometers, keep the block freely floating between its stops and thus under the control of the weighing apparatus.

In the preliminary tests it became plainly apparent that it would be almost impossible to read the load on the dynamometers, on account of the great variation, even during a single revolution. This variation was so extreme and rapid during each revolution that it was found quite impracticable to make any satisfactory observations of the load by this means. The inertia of the moving parts of the dynamometers and manometers was so great that one might at times as readily read 500 as 5,000 pounds. This irregularity was, however, completely overcome by the insertion of a small throttle valve (*A*, Fig. 3) between dynamometer and manometer, by means of which the movement of the liquid to and fro could be controlled exactly as desired.

During the run of one sea mile the pressure was read five times. The horse power was computed from diagrams taken at the same time, while the revolutions were counted by two observers and checked by tachometer. The course on which the trials were carried out was determined by ranges covering an official sea mile measured off on the island of Rosenburg, and the time for each run was taken by two observers.

On the whole, seven trials were made on this course, and at varying values of the speed, each trial comprising one run with and one against the tide, the two in immediate succession. The data resulting from these trials will be found in collected form in the accompanying Table I. In this table, in column 12 will be found the thrust power entered; that is, the power given by the multiplication of the thrust on the block, in pounds, by the speed per second, in feet, and the division of the product by 550. Column 13 gives the fraction of the total developed power utilized as work of propulsion.

TABLE I.

Number of Run.	I. H. P.		Revolutions.		Load on Thrust Block in Pounds.		Speed of Ship, Knots.	Speed of Propeller Knots.	Slip of Propeller.		Thrust Power.	Col. 12 / Col. 3
	Separate.	Mean.	Separate.	Mean.	Separate.	Mean.			Knots.	Per cent.		
1 up	33.25	31.03	96	94	1,895	1,907	6.97	7.08	.11	1.55	19.76	63.68
1 down	28.80		92		1,917							
2 up	48.06	50.56	110	111	2.827	2.762	8.07	8.36	.29	3.47	33.16	65.58
2 down	53.06		112		2,696							
3 up	81.40	80.24	128	127.5	4.081	3,566	9.02	9.60	.58	6.04	53.22	66.32
3 down	79.09		127		3 851							
4 up	132.82	132.35	148	148	5,950	5,968	10.07	11.14	1.07	9.60	89.43	67.57
4 down	131.89		148		5,988							
5 up	167.05	170.83	160	160.5	7,524	7,630	10.47	12.09	1.62	13.40	118.85	69.57
5 down	174.61		161		7,735							
6 up	234.13	230.58	175	175	10,244	10,007	10.84	13.12	2.28	17.37	161.40	70.00
6 down	227.04		175		9,771							
7 up	255.12	260.32	180	180.5	10,567	11,007	11 01	13.60	2.59	19 04	180.29	69.25
7 down	265.52		181		11.047							
1	2	3	4	5	6	7	8	9	10	11	12	13

Although the work was carried out with the greatest care, yet the results for efficiency showed certain values excessively high. These results must have been caused either by too high reading for the dynamometers or too low values for the indicator cards. It appears most likely that the latter was the case, as the dynamometers and manometers were very carefully standardized by direct loading with weights, and indications of slight error in column 6 thereby corrected. It would therefore appear that the developed power may have been greater than as indicated by the diagrams. This may have been in large part due to the fact that but one indicator was used on each cylinder. Through the influence of throttling and cooling, the effect in the indicator may have fallen below that in the cylinder. It would have been much better to employ two indicators, one for each end of the cylinder, and connected as directly as possible in order to reduce to a minimum all losses of this character. Nevertheless these results still have their value as a basis for comparison, since it may be confidently assumed, with engines of about the same size, that at least the relation between the power actually developed in the cylinders and that shown on the diagrams remains sensibly constant.

(To be continued.)

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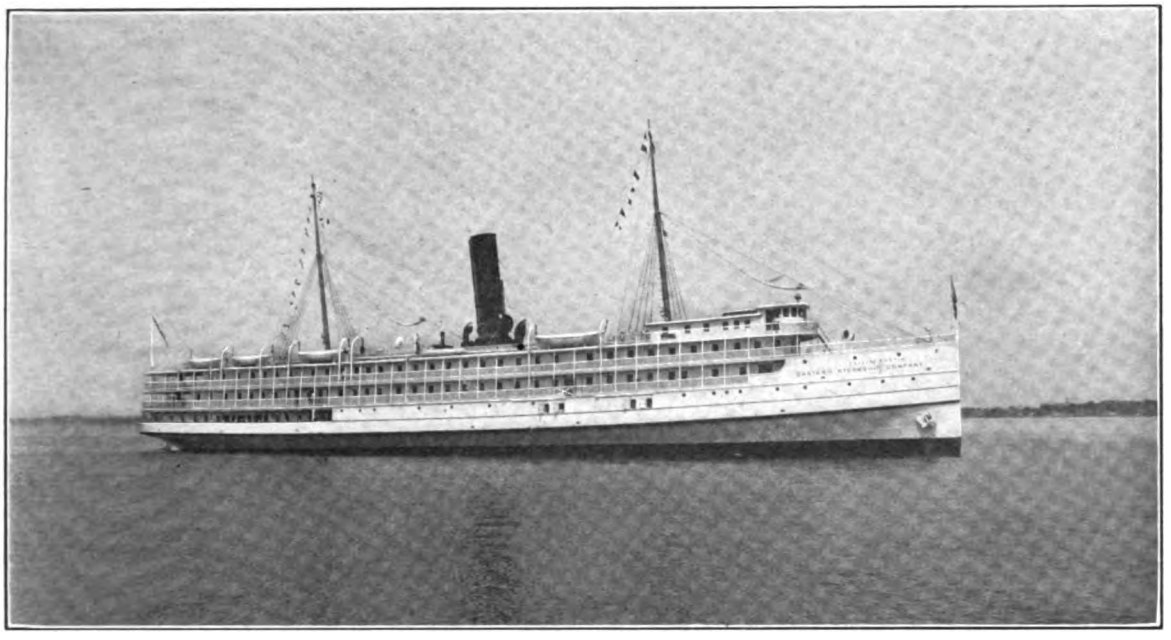

STEAMER CALVIN AUSTIN, FOR THE BOSTON AND PORTLAND LINE.

NEW STEAMER CALVIN AUSTIN, FOR THE EASTERN STEAMSHIP COMPANY.

There has just been built by the Harlan and Hollingsworth Company, Wilmington, Del., a fine new steamer for the Boston-Portland service of the Eastern Steamship Company. The new vessel is named the *Calvin Austin*, and is in many respects a duplicate of the steamer *Gov. Dingley*, now running on that line. She is what might be termed an intermediate type between the coasting steamer and the steamboat. Her over-all length is 320 feet, beam at the water line 48 feet 3 inches, and beam over guards 62 feet. The other dimensions are to be found on the data card at the end of this article.

INTERIOR ARRANGEMENT.

The interior of the ship has been laid out with an eye for the comfort of the passengers. The quarter deck or main entrance is on the main deck; aft of the engine space, on the starboard side, is the purser's office, and aft of this is a pantry. Glass doors open into the main dining saloon. Continuing aft is the ladies' cabin. Opening off the quarter deck are the coat and wash rooms, while on the port side is the crew's mess. The grand staircase leads to the hurricane deck above and to the lower deck. As shown in the joiner plan of lower deck, there are cabins forward and aft for men and women, along the sides of which are arranged six-berth rooms; each passenger is allotted a berth with a transportation ticket, as is the custom on Long Island sound and other lines. On the port side, abreast of the engine room, is the kitchen with adjoining pantries, while in the after cabin a table for the officers' mess is spread.

The main deck amidships and forward is given up to freight space, freight being loaded through large side ports, the doors of which are suspended on roller tracks. In the forecastle are the quarters for the firemen, sailors, etc., and the ship windlass.

Ascending the main stairway on the quarter deck one arrives at the main cabin on hurricane deck; double tiers of inside and outside state rooms run almost the entire length of the cabin. At the after end of each side are three large rooms with beds, amidships are the toilets, while forward there are bed rooms, linen locker, etc. The outside rooms are entered from the open deck, which runs to within about 45 feet of the stem. Forward of this bulkhead is the crew's space. This deck is not shown in the accompanying plans, as it is practically a duplicate of the gallery deck. Two large wells, one aft of the engine-room casing and one forward of the boiler casing, bring abundant light from large skylights above, to the main cabin on the hurricane deck. Handsome staircases are placed one forward and one aft. Above the gallery deck are the pilot house and officers' quarters.

The equipment of anchor, lifeboats, etc., is according to the United States rules. The ship is fitted with two pole masts and one funnel.

HULL.

The ship is built according to rules of the United States Standard Register of Shipping and is classed first grade, A 1, for 17 years. A double bottom extends from the forward to the after collision bulkheads. The keel is of the flat-plate type, 36 inches by 27 1-2 pounds. The central vertical keelson is 42 inches by 18 pounds, with double 3 1-2 by 3 1-2 inch by 10-pound angles at the bottom and 3 1-2 by 3 inch by 8-pound angles at the top. The side keelsons are intercostal, and breast hooks are worked at the end of each keelson.

In the wake of the water line the shell plates are increased in thickness for 60 feet aft of the stem for ice protection. The bottom, bilge, and side strakes are from 20 to 25 pounds amidships; the top, sides, and hurricane-deck plating are much lighter. The side stringer with clips and double continuous angles is worked in half-way from bilge to deck beams.

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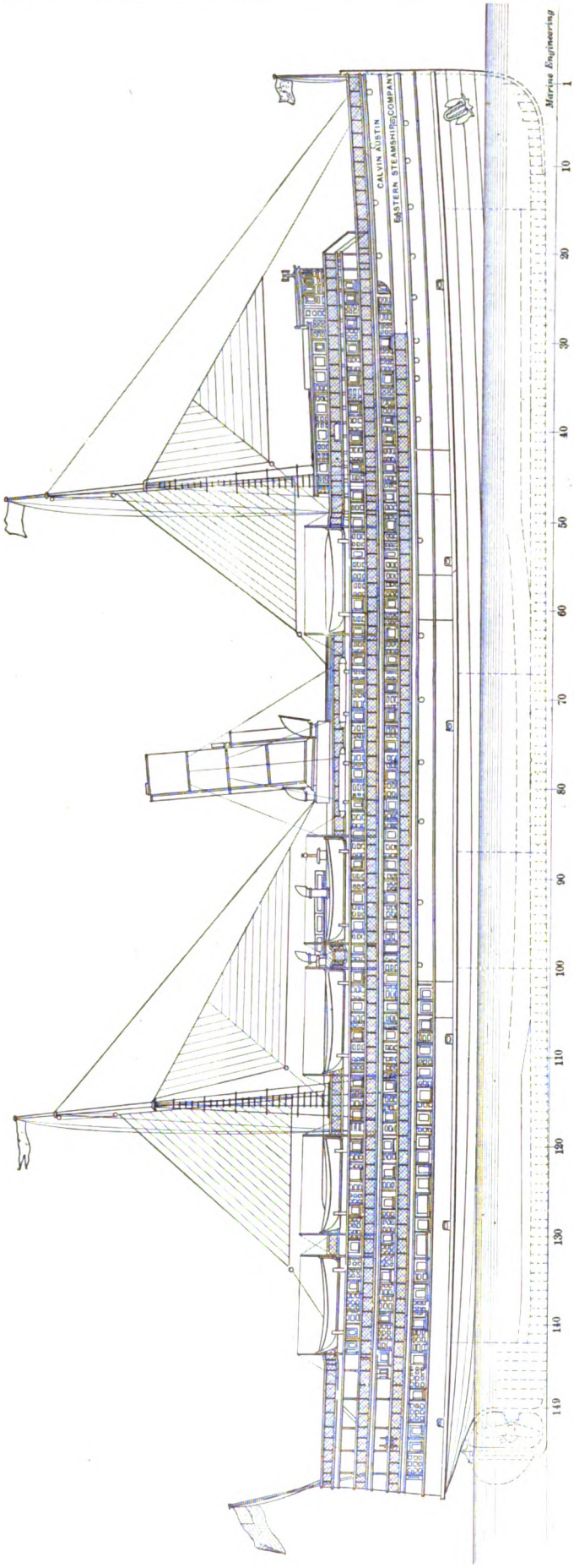

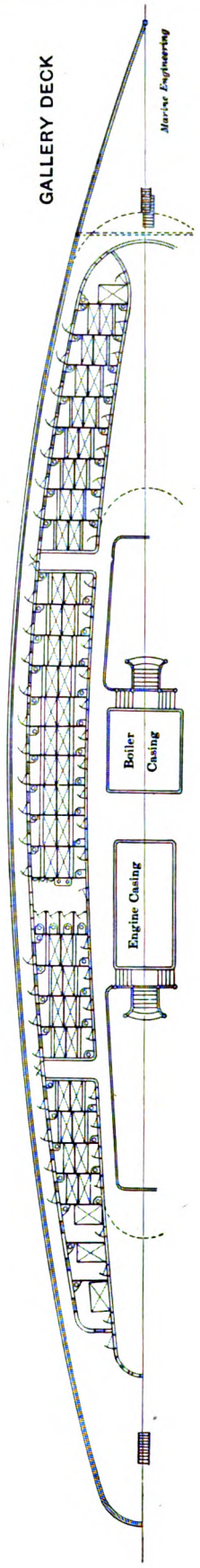

SAIL PLAN AND GALLERY DECK PLAN OF THE STEAMER CALVIN AUSTIN, BUILT BY THE HARLAN AND HOLLINGSWORTH COMPANY. THE LATTER PLAN IS PRACTICALLY THE SAME AS THE HURRICANE DECK.

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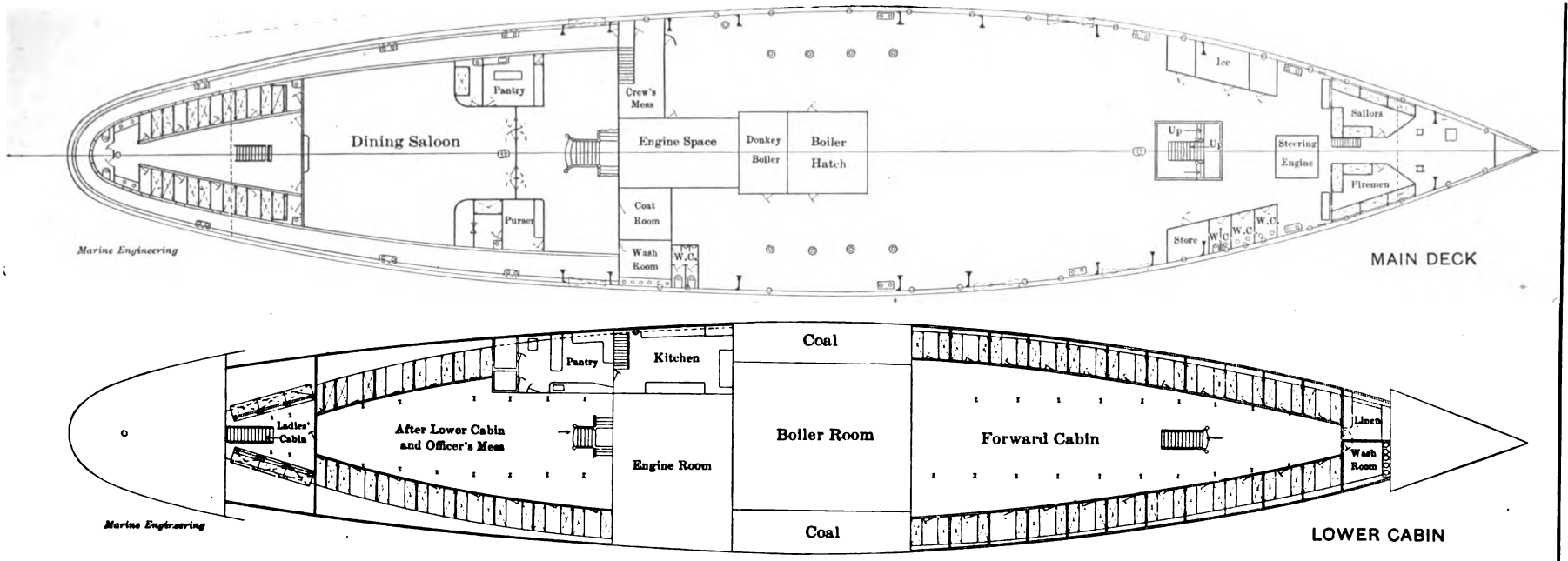

MAIN AND LOWER DECK PLANS OF THE NEW STEAMER CALVIN AUSTIN.

Frames are 5 by 3 inch by 10-pound angles in one piece to the main deck stringer and spaced 24-inch centers. The reverse bars are on each floor and extend in one piece to the margin plate, while the second part of the bars is riveted to the floor gussets and extends from the margin plate to the main deck. The floors are continuous from the center keelson to margin plate in the engine and boiler rooms; elsewhere they extend only part way to margin plate. Webs are spaced about every eighth frame and run from margin plate to the main deck. There is also a belt at each end of gangways. The main deck is of steel, 7 1-2 pounds, double-bottom plating is 14 pounds, increased in the engine and boiler room, and the foundation plate under engine is 3-4 inch.

Upper-deck beams are of Z bars spaced 18 feet; the main-deck beams are of channels spaced 3 feet, supported where necessary with double 6-inch channel stanchions.

There are 6 steel bulkheads, 4 of which are water-tight up to main deck, where they are fitted with double angle beams. Bulkhead No. 1 is forward collision bulkhead; No. 2 is forward coal-bunker bulkhead—both of these are water-tight and fitted with horizontal and vertical stiffening angles; No. 3 is aft of the boiler room and is not water-tight; No. 4 is aft of the engine room and is recessed into the shaft alley for the thrust bearing; No. 5 is at the after end of the shaft alley and carried to the height of the stringer; the shaft alley here opens through the bulkhead into a space which is flatted over to after collision bulkhead; No. 6 is after collision bulkhead, and is water-tight and stiffened to the main deck.

The stem is of hammered iron 9 by 2 1-2 inches, while the stern frame is of cast steel; the rudder is also cast with a solid blade and is supported from above.

MACHINERY.

The main engine consists of a 3-cylinder, triple-expansion engine, with cylinders 26, 43, and 71 inches in diameter by 42 inches stroke. The cylinders are mounted on cast-iron columns at the back, the condenser forming part of same, and on polished steel columns at the front. Piston valves are fitted to the high- and intermediate-pressure cylinders, and double-ported slide valve to the low-pressure. Pistons are of cast iron, fitted with Christie packing; the rods are 6 inches in diameter; the crosshead slides are of the bar type, made of cast iron; the crosshead is of cast steel, bolted to cast-iron box fitted to bar slide; the bearing surfaces of the box are run with Parsons metal; the connecting rods are forged steel, 94-inch centers.

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The condenser is fitted with 3-4-inch brass tubes, while the air pump is of the cross-simple Blake type, cylinders 10, 22 by 15 inches. Sanitary, feed, fire, deck, etc., pumps are of the Davidson type.

The shafting is of solid forged steel throughout. The crank shaft is built in sections 12 3-4 inches in diameter. The thrust is fitted with nine horseshoe collars and is 12 1-2 inches in diameter. The line shaft is 12 1-8 inches in diameter and the propeller shaft is 12 7-8 inches in diameter. Water circulation is provided for main journals and crosshead slides.

The ship is lighted throughout by electricity from two 35 K. W. General Electric generating sets driven by simple engines. Ventilation of the galley and boiler rooms is provided by a Sturtevant engine-driven fan placed on the grating in the upper engine room.

Four single-end Scotch boilers supply steam of 175 pounds pressure. They have a common fire room and coal is handily supplied from wing bunkers. Two large ventilators carry air down to the fire room. Air is also supplied through ducts overhead from the ventilating fan placed on a grating in the upper engine room. The uptakes in the four boilers lead to a common funnel.

On her run to Boston from Wilmington the *Calvin Austin* underwent a successful trial, and the engines developed 2,600 I. H. P., the highest being 3,100, and the speed was 18.9 miles per hour.

Name—Calvin Austin. **Nationality**—American. **Type**—Coasting passenger steamer.

Launched—1903. **Builder**—Harlan and Hollingsworth Co. **Owner**—Eastern Steamship Co.

Length over all	320 ft.
" between perps	300 "
Beam on water line	48 " 3 ins.
" over guards	62 "
Depth, molded, to main deck	21 "
" between decks	9 "
Draft, loaded, aft	16 "
" " forward	10 "
Displacement, loaded	about 2,600 tons
Draft, launching	6 ft. forward by 11 ft. aft
Speed, load draft	18 miles
Dead weight carrying capacity	280 tons
Tonnage, gross	3,826
" net	2,553
Engines: Number	one
Type	three-cylinder compound
Cyl. diams.	26, 43, 71 ins.
Stroke	42 "
Valves	Piston on H. P. and I. P.
Revolutions, designed	90 to 100
I. H. P. "	2,600
Condensing surf.	4,450 sq. ft.
Air pump	Blake
Shafting: Crank, diam.	12 3-4 ins.
Thrust, diam.	12 1-2 "
Line, "	12 1-8 "
Propeller, "	12 7-8 "
Propeller, diam.	15 ft. 3 "
Boilers: Number	four single-end Scotch
Diam.	14 ft.
Length	12 "
Tubes, each	2½ 3-inch
Furnaces	3 each; inside diam. 44 ins.
Grate bars, length	6 ft. 6 "
G. S., total	286
I. H. P. ÷ G. S.	9.0

Costly Mistakes.

The tendency to overlook a glaring error in the search for a trifling one is so old that we are ever warned in Holy Writ in the well-known verse about the beam and the mote. It would seem, however, that in modern engineering the numerous safeguards of the system in an up-to-date works would take pretty good care of such oversights. That this is not true none of us who have ever been employed in such places will doubt for a moment. Frequently errors of this sort are spotted by the careful foreman or mechanic, even when they have slipped past the watchful eyes of the draftsman, the checker, the designer, the chief draftsman, the chief engineer, the general superintendent, etc., and are then mainly useful as an aid to the clumsy wit of the outside man in his efforts to belittle the "white shirts" in the office. Sometimes, though, the error goes right through, and is only brought to light when the erring pieces are finished and assembled; and then—somebody is in trouble.

The writer knows of one case, in a prominent English shipyard, where not until her trial trip was it discovered that a right-hand engine had been equipped with a left-hand propeller! The latter was a four-blade solid casting, and there was trouble for many people, and a great many dollars, or pounds sterling, expended in making things right. In another large foreign yard one of the finest modern English cruisers was building in a rush, and when the engines were erected in the shops it was discovered that the cranks would not clear the columns. There was no time to make new parts, so the columns and cranks were both chipped, with the old hammer and chisel, until they cleared. As this had to be done on twelve columns and six cranks, it is likely that it was not a very cheap job, to say nothing of the weakening of the parts chipped and the additional expense for strengthening them. What her majesty's inspector had to say about the job was not quoted.

For some time the writer was employed as an engineer on a modern 20-knot liner. Her propellers had been giving some trouble, and she was ordered to dry-dock to have new blades fitted, the six blades, of manganese bronze, being put aboard of her in her home port. The dry-dock was a trifle over 3,000 miles from this port, and when she had arrived there, and the six shiny blades had been carefully gotten out, a close inspection convinced the authorities that there were four right-hand and two left-hand blades instead of three of each. There being no time to waste, as she was only allowed a week off the line, three of the right-hand blades were fitted and two of the left-hand. For a third left-hand blade one of the old ones was used with the holes in the boss enlarged so that it could be brought into approximate pitch with the two new ones, the new wheel being nearly two feet coarser pitch than the old. Then she left the dock and went to her berth to load.

A few days later her sister arrived with orders for a similar job; and a careful inspection of her new blades showed that she had been given four left-hand and two right-hand ones. An exchange was made, so ship No. 1 went back into the dry-dock and had the

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new blade exchanged for the makeshift. Just what this little mistake cost I do not know; but dry-dock privileges are not of the cheapest. It also takes a good mechanic to distinguish between a right- and left-hand blade of the sort used on these particular ships.

Another ship on which the writer was employed belonged very nearly to the genus tramp. She had a small triple of about 1,200 I. H. P., and by shaking her up and feeding the two firemen and the coal passer a little "Dutch courage" we could, in the current, with a fair wind, get nearly 11 knots out of her. She would have been just about the home the seagoing man yearns for, except for the metallic packing on her valve spindles. This was contained in the usual casing, and just below the casing was the guide bracket for the spindle. This allowed the casing to be dropped such a small distance that it was next to impossible to see anything inside, and all inspection, fitting, etc., had to be done by crooking one's fingers over the edge and feeling around inside. Thus what should have been a comparatively easy job was one of the meanest on the ship. Moreover, there was no necessity in the design of the engine for causing this inconvenience; and we used fervently to pray that the man who made her drawings might be obliged to get out and put in that valve-spindle packing.

During my early seagoing days it was always a mystery to me why chief and second engineers had such a cynical and distrustful way of coming around with lamps and candles, and looking into every cylinder, steam chest, boiler, pipe, etc., that I had opened in port. I discovered why in this wise: An engineer, and an experienced one at that, had taken out the L. P. valve in port. Before closing the chest he had called the second, who approved it. The valve at the time was hanging partly lowered into place. It was a large, flat valve of the trick pattern, and was taken out by means of two 5-8 eyebolts screwed into the top end. It was lowered into place and the chest closed. Before sailing the engine was turned over by a hand-turning gear and everything seemed clear and easy.

Less than twenty miles from port, being still in the river, the engine set up such a row that the chief came down himself and took a card off the low-pressure cylinder. When he looked at the diagram he sent word to the skipper that it was best to anchor, which we did. An investigation showed that the eyebolts had not been removed when the chest was closed; and while they must have cleared at first, as turning her over by hand had been so easy, the subsequent vibration loosened them so that a hole about 6 by 4 inches was knocked into the hollow top of the valve and the loose pieces were caught in the ports—which were bolted on to the cylinder casting, and not part of it—and broken chunks out of them. One of these got over on top of the low-pressure piston, which was a hollow casting, and punched a hole in it and slightly sprung the rod.

Luckily we were not far from shore, so a small boat hunted up a landing and the state of affairs was telegraphed to the office. A tug responded, and the injured piston, rod, and valve were sent away to the shop for repairs. The edges of the broken ports were chipped clean and wooden templates made, from which brass castings were made ashore and put in place with countersunk screws. This was a number of years ago, and the last time I saw the ship these patched-up parts were still giving a good account of themselves. The delay, I think, was just 52 hours, a small percentage of the time usually allowed for the voyage. This turned out pretty badly for the second and the man who did the job but forgot the eyebolts, but it was a beautiful lesson to the rest of us.

More than once since then have I sneaked out the night before sailing and, with a friendly oiler to help, opened up steam chests, cylinder-cover manholes, evaporator doors, *et al.*, on the dread suspicion that there might have been a hammer, or a monkey wrench, an eyebolt, a chisel, a rope sling, or even a stray bunch of waste overlooked when I closed it up. This was especially the case under one second engineer. He had been thriving so on the company's bill-of-fare that one day when he dropped through the manhole in the L. P. cylinder it took two burly firemen and myself to get him out; and when he came he left behind the nether half of his "b'iler suit" and all his peace of mind. He would never go in there again, but instead, upon my reporting that I was ready to close up, would fix a stern eye upon me and go on thus:

"Ye're pairfectly sure ye left no gear in there?"

"Yes, sir."

"Verra well; remimber, I thrust ye absolutely, an' tek yer worrd for it. Away doon and close 'er up, and dinna fergit to swab her oot well wi' cylinder ile and black lead."

Tech.

De Forest Wireless Telegraph.—Several stations of the De Forest Wireless Telegraph Company, which owns the patents of Lee De Forest, an American, are receiving and transmitting wireless messages commercially. The station at Point Judith is transmitting 2,000 words nightly to Block Island, and it is reported that the system works perfectly, no interference from other wireless systems which are in that neighborhood being noticed. The De Forest system, under government tests, successfully transmitted messages at the rate of 52 words a minute, which is far in excess of other systems tested.

United States Shipbuilding Company's Affairs.—Since the appointing of ex-Senator James Smith receiver of the United States Shipbuilding Company, by Judge Kirkpatrick, there has been continual contention between the reorganization committee and the protesting bondholders. Application was made in each State wherein the shipbuilding company owns properties for the appointing of a receiver, and Judge Putnam, of the United States Circuit Court of Maine, refused to appoint Receiver Smith ancillary receiver for the company in that State. The receiver has signed an order terminating the leases of the subsidiary companies, which leases are terminable at the option of the shipbuilding company on five days' notice. The reason for this was to bring all the properties under the authority of the receiver. Otherwise they would have continued under the charge of the subsidiary companies, over which the receiver had no control. The contesting bondholders claimed that there was no reason for the appointing of a receiver. At the present time the company's affairs are much tangled, and the lines along which the reorganization will finally conform cannot now be seen.

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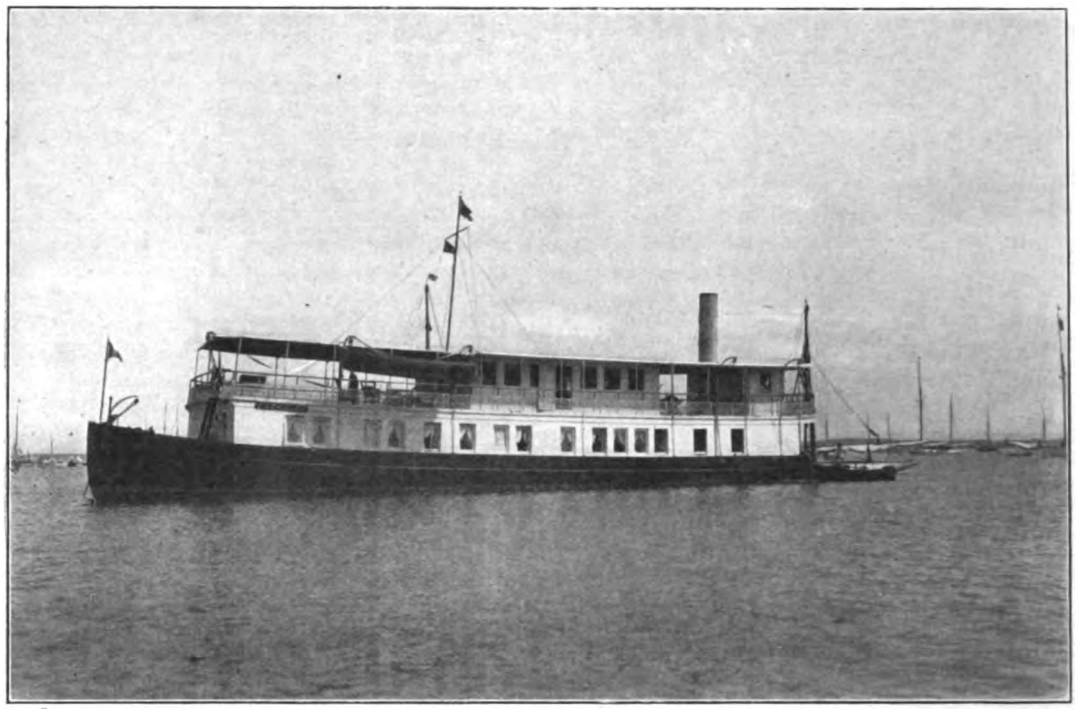
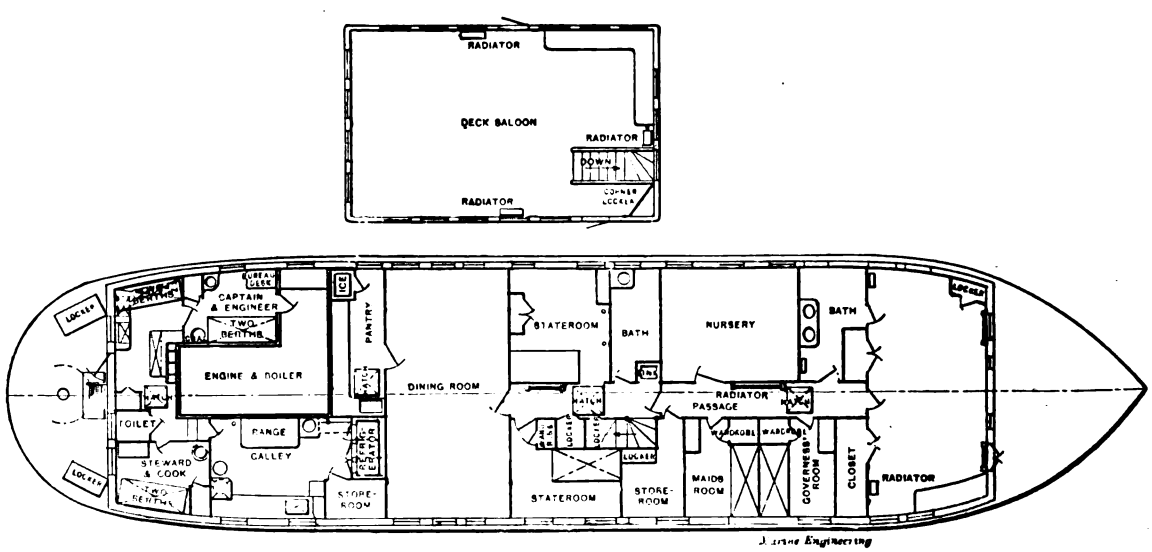


STEAM-PROPELLED HOUSEBOAT CACHALOT.

THE HOUSEBOAT FOR SUMMER OUTINGS.

The phrase "Necessity is the mother of invention" might be changed to read, "Pleasure is the mother of invention," in this country of ours, for truly it is that thousands of our citizens are daily enjoying pleasures which were formerly considered pastimes of a king and are the results of many inventions and years of study. While our engineers have designed efficient means for heating offices and residences, as yet there are no general arrangements for cooling the home or office during the hot summer days and nights; so it is that one looks for relief to the cool breezes of the mountains or seashore for rest and recreation.

The pleasures of the sea have been taken advantage of by increasing numbers, who spend their vacations at either seaside hotel or on board the yacht. To combine the comforts of shore with the pleasures only obtainable on the water there has been brought out of recent years a new style of boat, most properly termed the houseboat. Each year sees a few more of these convenient little craft added to the list.



CABIN PLANS OF THE CACHALOT, DESIGNED BY TAMS, LEMOINE AND CRANE.

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of this form of home for spending one's vacation. The modern houseboat is generally provided with an engine for propelling it at a moderate speed along the inland waters of our coast, and thus one's tent may be pitched wherever inclination or fancy dictates.

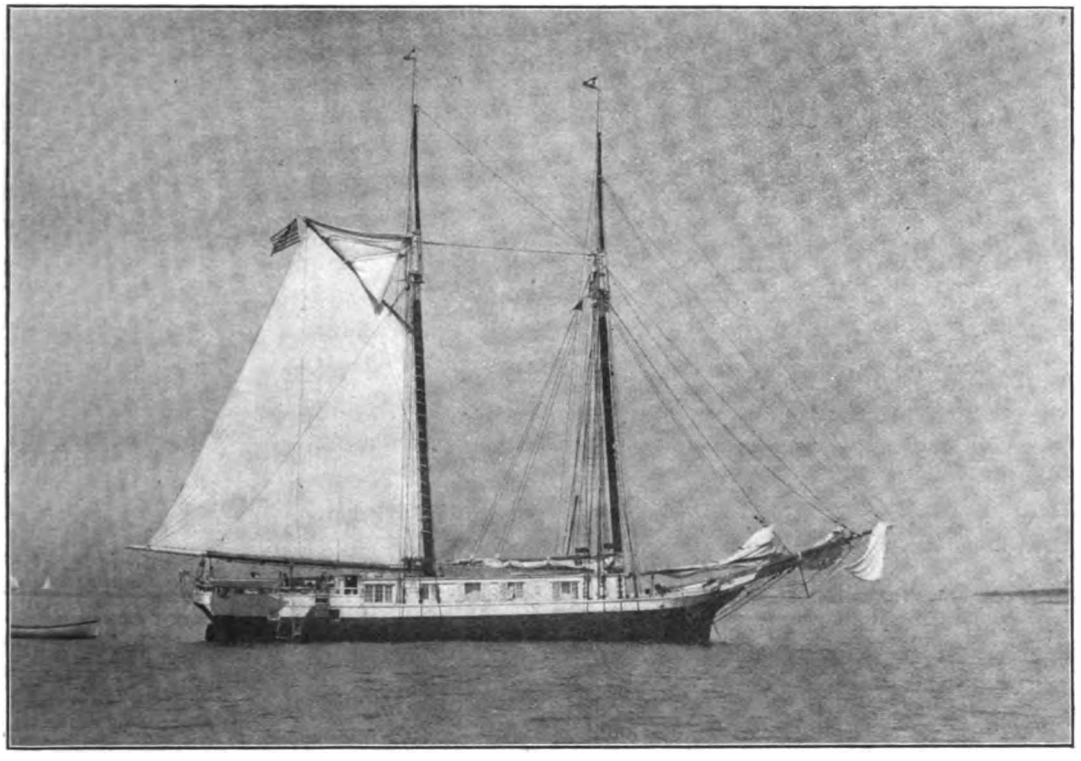
The fundamental design of a houseboat is not that for sailing (or steaming), but of comfortable and economical living afloat. The English houseboat, the predecessor of our type, has no means of self-propulsion other than being fitted with oars. It is not often desired to be moved, and then a tug or a launch is secured. It is used on the small rivers of the island. The conditions here are quite different, for the houseboat is largely used on the salt water, where the owners desire to go from one to another of the many shore resorts on bay or sound.

The price of these boats depends altogether on the size of the purchaser's pocketbook, but for the same amount of money invested in a sailing yacht as in a houseboat the accommodations of the latter are many times larger. A good, comfortable boat can be built for $800, while some of the large, handsome boats cost $25,000 and even more. As the term implies, the houseboat is a house built on a boat; it is impossible to make the craft look shipshape according to the established nautical ideas, and the *boat* is a second though necessary consideration.

The *Cachalot*, an engraving of which will be found on page 424, shows a high development of this self-propelled type. The boat is 100 feet long over all, 22 feet 6 inches beam, molded, 12 feet depth of hold, and draws 6 feet of water at the stern. She was designed by Messrs. Tams, Lemoine and Crane for a lady and her children, and the contrast between this and that of the *Bonita*, to be described later, shows how successfully plans may be drawn to meet special requirements.

At the forward end of the house is a large room for the owner, 10 feet 6 inches long and the full width of the boat. A passageway leads aft from this room, opening into two bath rooms, nursery, and state room on the port side, and governess' and maid's room, stairway, and state room on the starboard side. Very large closet space is given, and there are two large hatches in the passageway; the hold is exclusively for stores. The after end of the passage opens into a large dining room, 10 feet 9 inches long, the full width of the boat, while directly aft of it are the pantry, store room, and galley. A window opens from the pantry into the galley. The refrigerator is divided up into four compartments, the ice being placed overhead; another compartment being used for general stores, one for milk and butter, and a third for meats. The galley is well equipped with range, dresser, and sink. In the engine and boiler space is placed an Almy water-tube boiler, a compound-condensing engine, and an electric-lighting plant. The captain and engineer have a state room on the port side opening into the engine room and also into the mess room aft. Another state room is placed on the starboard side, and in the mess room are swung two berths. On the deck at the after side of the house a stairway leads above.

In the passageway forward will be found a staircase which leads to the upper saloon, a large room about 30 feet long and 17 feet wide. The quarters throughout are heated with steam and lighted by electricity.



A NOVEL TYPE OF SCHOONER HOUSEBOAT, THE CLARINA.

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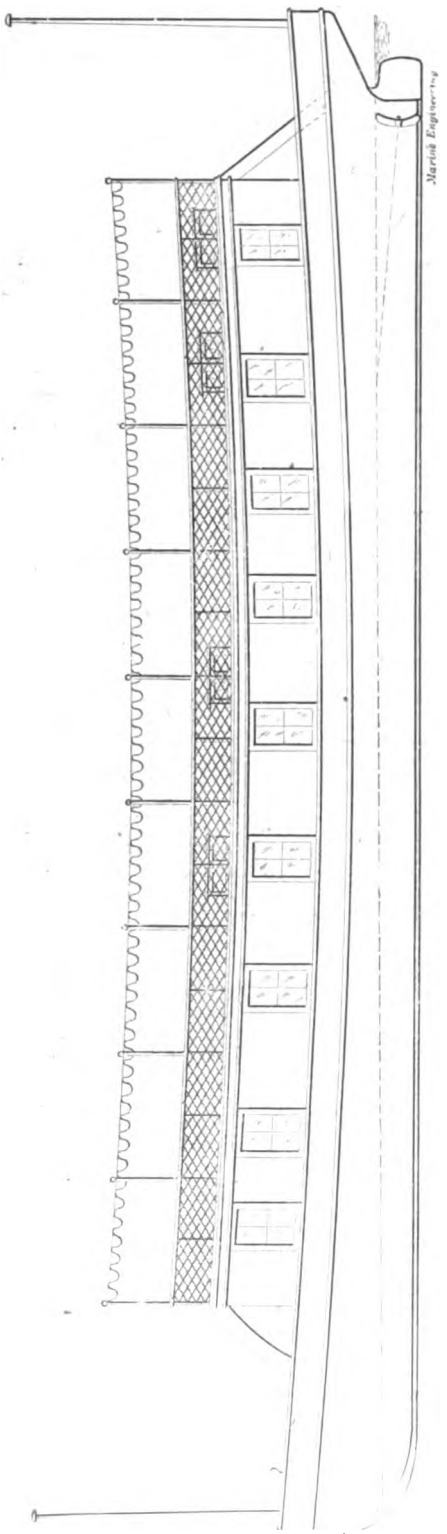

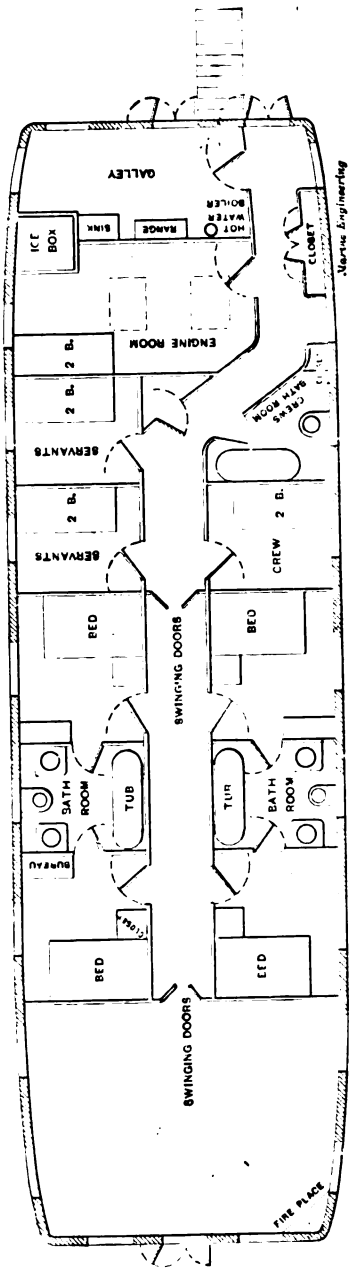

ELEVATION AND CABIN PLAN OF THE BONITA, DESIGNED AND BUILT BY THE MESSRS. OSBORN.

A somewhat similar craft is that owned by General Louis Fitzgerald and now in Southern waters. The houseboat is named the *Bonita*, and was designed and built by the Messrs. Osborn at Croton-on-Hudson, New York. The general dimensions are: length on deck, 100 feet; beam, 23 feet; depth of hold, 4 feet 6 inches; and draft, 3 feet. The hull is framed of oak and chestnut; the keelsons, clamps, and planking are of yellow pine. The main keelson is carried up to the deck with 4-inch stuff, forming a longitudinal bulkhead the length of the boat. The deck is of cypress, and the sides are sheathed to 6 inches above water line with 16-ounce yellow metal. The hold of the boat is used only for naphtha and water tanks, store rooms for provisions and trunks, etc.

It is the house, however, which is the most interesting part of this convenient craft. It is 74 feet long, leaving a forward deck 15 feet and an after deck 9 feet in length, and it is 22 feet wide. The tumble home of 3 inches on each side, the guard projection of 3 inches, and a deck of 6 inches all give the house a good protection for coming into locks or lying at docks, etc.

The windows are fitted with diamond-shaped glass panes, sliding forward and aft, and also each window is fitted with blinds and with wire screens. The upper deck has a galvanized pipe railing and wooden stanchions supporting an awning. This deck is reached by winding stairs forward and straight stairs at the after end. A 22-foot gasoline launch and three 15-foot rowboats are carried on the aft deck, swung on davits.

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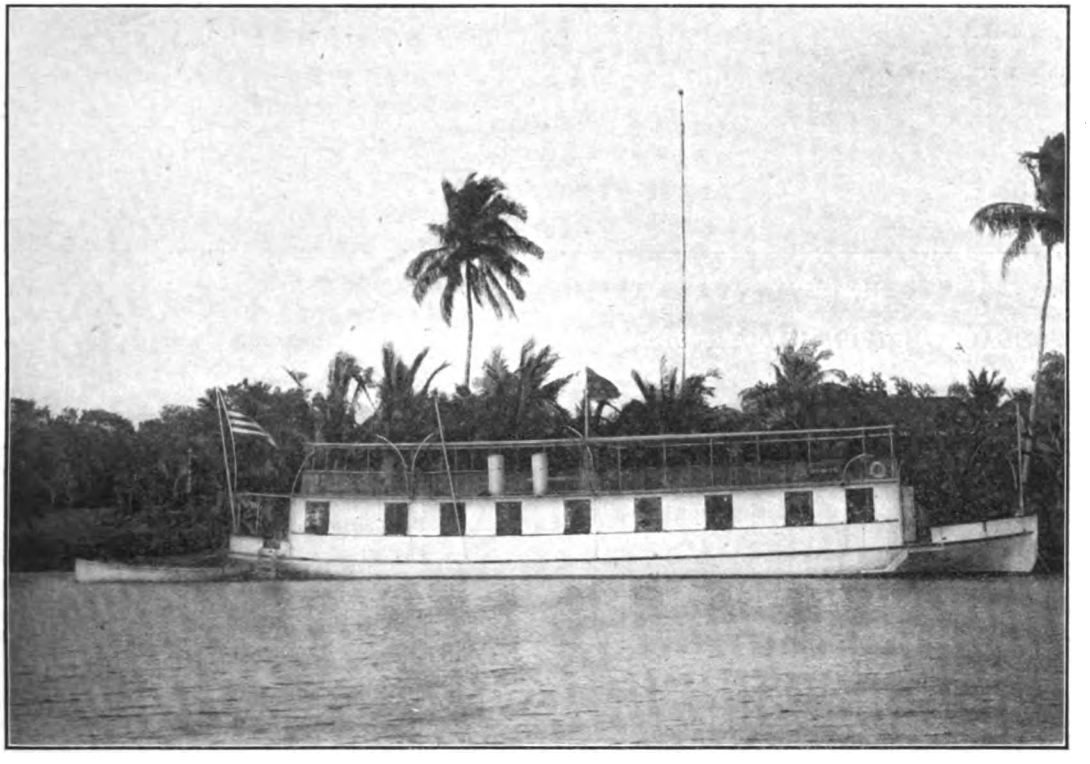
The arrangement of the house is shown in the plan on page 425. At the forward end is the main saloon, 16 feet long and the full width of the house, with a corner fireplace. A passage 4 feet wide leads aft from this saloon through swinging doors, and from it open off four large bedrooms 8 by 10 feet. Between the rooms on each side is a large bath room, with connecting doors to the two rooms. Each bath room is 7 by 10 feet, contains a large tub, two basins and closet, the plumbing being of modern sanitary type. The tubs are supplied with hot and cold fresh water and cold salt water. The doors at the after end of this passageway lead into the crew's or servants' space, there being three 2-berth state rooms, a bath room, and several large closets.

Before closing some mention should be made of the floating hotels which a philanthropic capitalist of New York equipped and ran two summers ago. These consisted of old sailing vessels made over, with many sleeping rooms. Those who wished to rent a room on board for the night were carried from the city in special tugs, placed on the floating hotel, and these latter were towed down the bay and anchored near Sandy Hook until early the next morning, when they were towed back to the upper harbor. The season in which they were started was an exceedingly warm one, both afloat and ashore, and the discomforts of the floating hotel were almost as great as those ashore. It was not a popular venture, and the boats have since disappeared.

The houseboat is bound to increase in popularity, especially with those of moderate means, for with what a man with a good-sized family would pay for board at a summer hotel he can build and equip one of these boats and be independent of hotel proprietors or land agents, and he may change his camp without even packing a trunk.



TWIN-SCREW, GASOLINE-PROPELLED HOUSEBOAT BONITA.

In the engine room are two 25 horse-power Globe gasoline engines, each driving a 30-inch screw, and in one corner of the room are two berths. The gasoline for the engines is stored in copper tanks at the extreme bow, the space being bulkheaded off from the main hold. A galley, 9 by 14 feet, is at the after end of the house, fitted with range, sink, dressers, hot-water boiler, ice box, etc.

This boat can be driven at a speed of about 8 miles an hour, and thus, it will be seen, almost reaches the cruising class of yacht.

A third and simple type of houseboat is illustrated on page 425. Here the owner has taken a two-masted schooner and built a comfortable large deck house between the masts. The boat does present an unusual appearance with its clumsy deck house and its bay windows, but comfort is the keynote of this class of boat, and in all the designs light and airy quarters, large cabins, and plenty of head room have been secured.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 140 vessels of 48,166 gross tons built in the United States and officially numbered during the month of June, 1903. The largest steel steam vessels included in these figures are: *James H. Reed*, 5,598 gross tons, Wyandotte, Mich.; *D. M. Clemson*, 5,531 gross tons, West Superior, Wis.; *Sonoma*, 4,539 gross tons, West Bay City, Mich.; *B. Lyman Smith*, 4,271 gross tons, Lorain, Ohio; *Calvin Austin*, 3,826 gross tons, Wilmington, Del.; *Larimer*, 3,737 gross tons, Camden, N. J.

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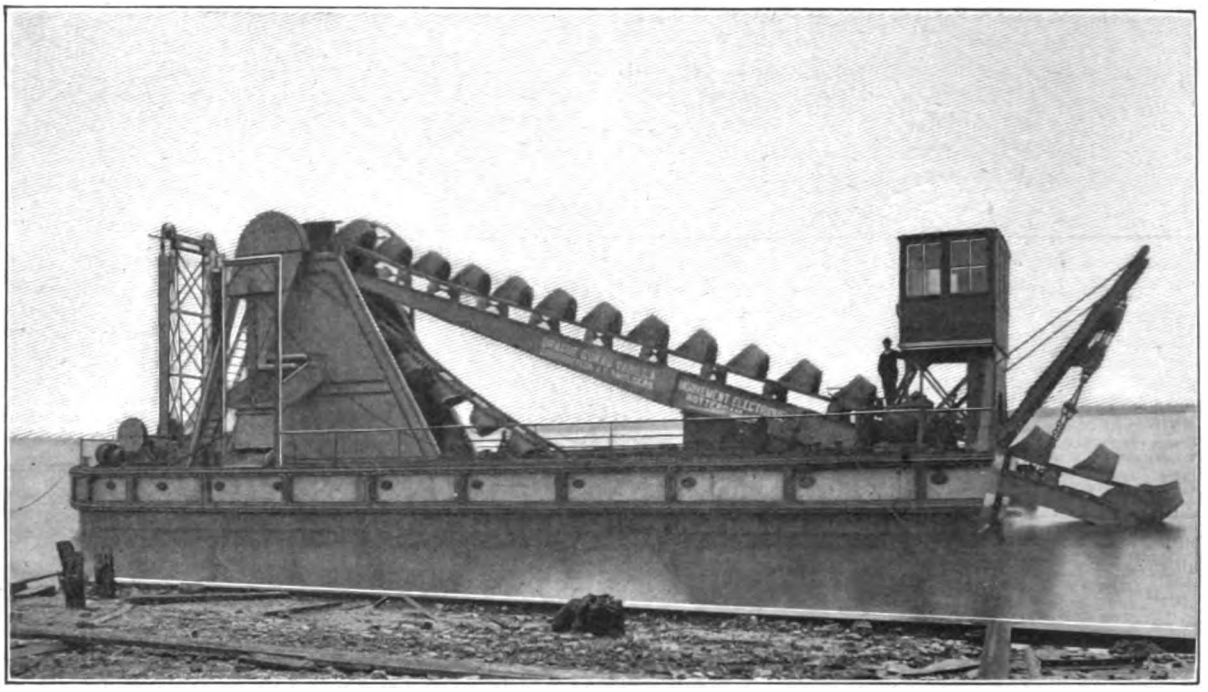

ELECTRICALLY-DRIVEN LADDER DREDGE, FOR USE ON THE RIVER ESLA, IN SPAIN.

ELECTRICALLY-DRIVEN LADDER DREDGE.

The type of ladder dredge constructed from the designs of Mr. Bunau-Varilla by the firm of A. F. Smulders, Rotterdam, Holland, is in use for dredging ballast on the river Esla, near Benevente, in the province of Zamore, Spain. The chief point of interest in this dredge is in the fact that it is electrically driven throughout.

The current is generated at a high pressure at some suitable point on the river bank, and conveyed to the dredge by means of overhead wires or suitably protected subaqueous cables. The same generating station also supplies the power needed for working the conveyer by means of which the ballast received from the dredge bucket is transported and tipped into the ballast wagons.

The general appearance of the machine is well shown above, whilst the details of construction will be understood on referring to drawings on the following page.

An entirely novel system of anchoring the dredge, and of traversing it and moving it forward, has been adopted, since no anchorage or mooring chains are used, the sole connection between the river banks and the dredge being the electric cable, so that the free movement of other vessels up and down the stream is unimpeded, even while the dredge is at work. The method of procedure is as follows:

The proper position for beginning work having been attained, a heavy pile is sunk through an opening purposely left in the bow of the boat (see drawings), and driven into the river bottom, thus forming a fixed point about which the vessel can swing. This swinging is effected by the electrically-driven screws shown at the stern of the boat.

Trials made in the Meuse on February 4, 1896, showed that the dredge could be kept up to its work, broadside to the full tidal current, with only one of the two screws in action. The buckets came up full, the work being carried out without the slightest hindrance, although the start was made on entirely new ground.

The method of advancing the dredge to a new position is equally novel. As will be seen, a second pile hole is placed near the bow of the boat at a distance of 6 1-2 feet from that previously referred to. In shifting to a new position the dredge is swung at an angle to its desired course, and another pile is then driven down through this second hole; the first pile is then lifted and the dredge is swung back till the central pile hole is over a point in the channel some feet in advance of its previous position. The central pile is again lowered and the side pile withdrawn, after which the work of excavation goes on as before.

The piles are made of steel tubing, and are heavy enough to enter an ordinary river bed by their own weight, whilst in the case of very hard ground they may be filled with lead. The lifting and lowering of the piles is, like all the other operations of the dredge, controlled by a single attendant, all the necessary switches being grouped in the cabin shown at the stern of the boat.

The chain of buckets is driven by a three-phase motor of 30 K. W., which, however, is capable at a pinch of developing 50 per cent. overload. It is, like the motor working the pile gear and the ladder crane, designed to run at 600 revolutions per minute, the necessary reduction in speed being effected by gearing.

The operations of starting and stopping can be effected with great rapidity, and the speed when running is perfectly constant.

The torque exerted varies greatly as the buckets pass over the tumbler. Running empty, the current, taken

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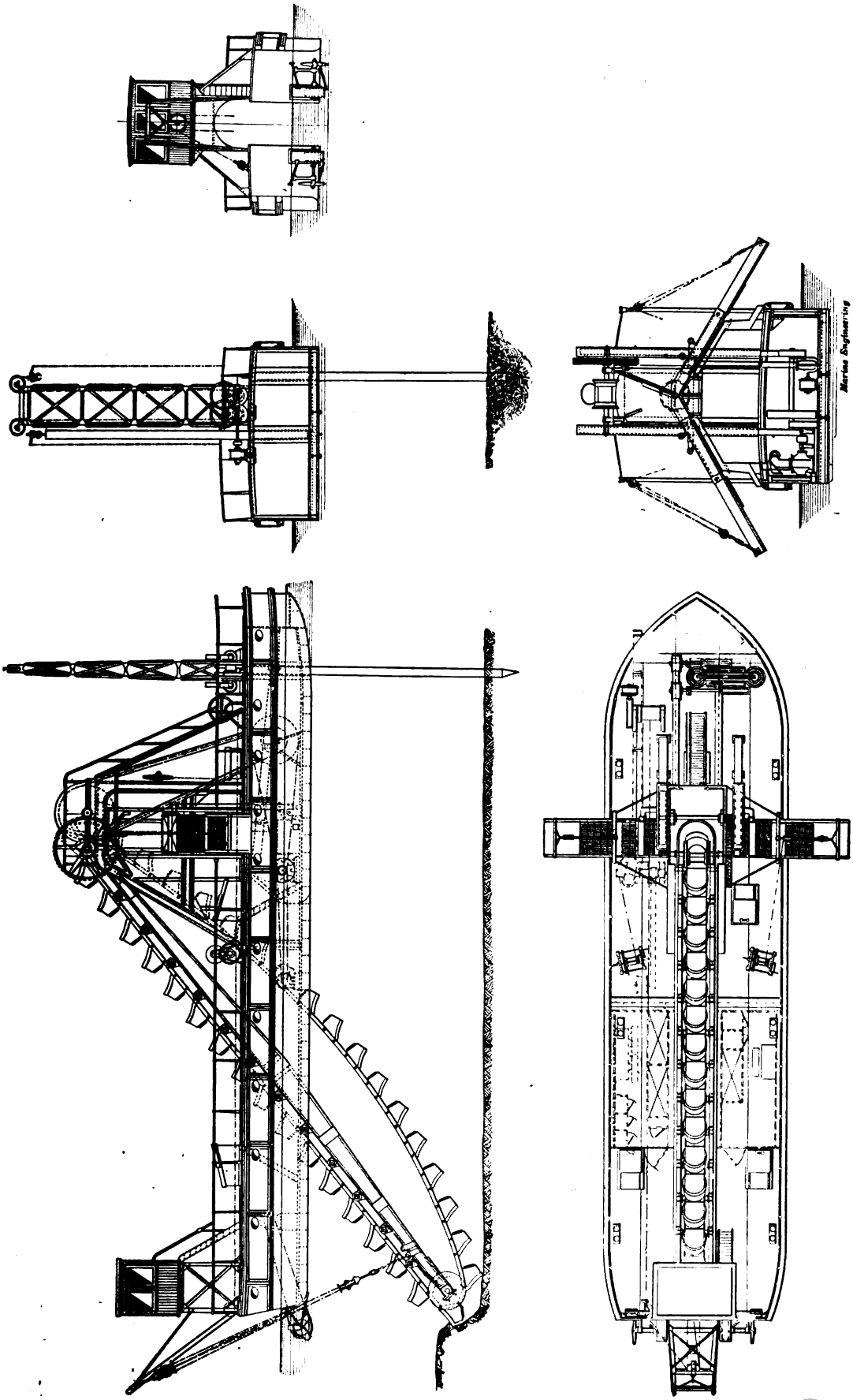

PLANS, ELEVATION, AND SECTIONS OF AN ELECTRICALLY-DRIVEN DREDGE, BUILT BY THE FIRM OF A. F. SMULDERS, OF ROTTERDAM, HOLLAND.

as the bucket rises over the latter, corresponds to falls to zero. With a full bucket the ordinary maxi- average demand may be taken as 20 K. W. only, thus 27 K. W., while when the summit is passed the current mum effort corresponds to about 40 K. W., so that the leaving a very large reserve of power. Should, how-

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ever, the resistance met with exceed the maximum power available, the fuse on the motor circuit blows, thus saving the apparatus from damage. The replacement of this fuse is, of course, only a matter of a few minutes.

The generator selected delivers to the mains a triphase alternating current at 2,000 volts. This is transformed on reaching the dredge to a 200-volt current, with which the different motors are designed to work. These are seven in number, two being employed for driving the screws, one for lifting the ladder, one for driving the chain, two for the pile gear, and one for a centrifugal pump, the discharge from which is used for washing the ballast free from sand.

CURTIS STEAM TURBINE.

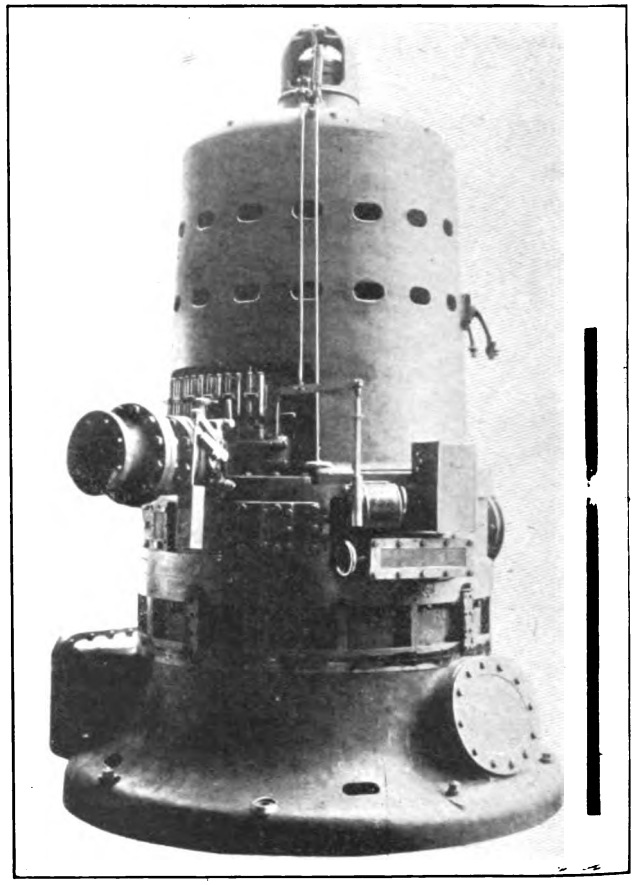
That the steam turbine has quickly assumed a prominent place in steam engineering can be attested by orders which the different manufacturers have to-day on their books for this form of prime mover. The steam turbine was practically unknown until a few years ago, and it is only within the last three years that it has been used at all in this country commercially; while to-day it is estimated that there are many hundred thousand horse power of steam turbines under manufacture. It is well known that the first form of steam engine, the old Hero engine, was that of a steam turbine; but for many centuries this type was set aside, and under James Watt the reciprocating engine was developed.

The two general principles on which different turbines have been constructed are: First, transformation through a nozzle of the potential energy of the steam into kinetic energy of motion; thus the steam is expanded from boiler pressure to the exhaust pressure in a carefully designed nozzle where all its energy is transformed into energy of motion. Steam at 150 pounds boiler pressure exhausting into a 28-inch vacuum will attain a speed of over 4,000 feet per second. In the De Laval type turbine the steam impinges on a series of radial buckets on a disk, driving the latter at a very high speed. Theoretically 100 per cent. efficiency would be obtained with the vanes traveling at one-half the velocities of the steam; practically this speed in the De Laval turbine has been reduced to about 1,200 feet per second. The rotating member is supported on a light shaft resting in double spiral gears to reduce the velocity 1 to 10.

The other general principle on which turbines are built is that of the expansion of the steam in the turbine, similarly in principle to that of the steam engine. The Parsons turbine embodies this principle. The steam enters a long cylindrical casing in which is a rotating cylinder with successive series of blades mounted radially upon it. The steam first strikes the blades on the rotating member, then the blades on the casing, then the second series of blades on the rotating member, and so on, back and forth, throughout the length of turbine. Expansion takes place at each set of blades, and the steam is exhausted in the condenser. It is usual to divide the cylinder into three parts, called the high-, intermediate-, and low-pressure stages, the high being the smallest, the intermediate larger in diameter, and the low still larger in diameter.

With these brief general remarks as to the types of turbine, we now pass to the Curtis turbine, patented by Mr. C. G. Curtis, of New York. It embodies a combination of the above-mentioned principles. Steam at, say, 170 pounds pressure, absolute, is expanded in several nozzles to about 20 pounds pressure, absolute, and this amount of potential energy changed into kinetic energy is abstracted fractionally, that is, by a series of wheels fitted with buckets. When the steam has thus given up its velocity, the potential energy is again transformed into kinetic energy by expanding in a second group of nozzles, and the energy as far as may be is turned into velocity, which velocity is again abstracted fractionally by a second series of wheels.

Briefly described, the Curtis turbine consists of three



CURTIS TURBINE, DIRECT-CONNECTED TO A 500-KILOWATT GENERAL ELECTRIC GENERATOR.

or more revolving disks of rolled steel with buckets cut radially into the periphery of each disk. The disks are mounted on one shaft, placed in a casing. The sides of the casing about the disks are removable, and have attached to their inner surface rows of stationary buckets arranged to fit in between the revolving disks, and the inclination of the surface of these buckets is reversed to those of the revolving members. Steam enters through several nozzles, arranged opposite to the stationary members, and is discharged against the buckets of the disks at a high speed. After passing through one disk the steam is caught by the stationary buckets, its direction reversed and thrown against the second revolving disk, and the operation is repeated by

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each set of stationary and revolving members until its kinetic energy has been removed and it is led into the condenser.

The Curtis turbine is generally divided into two or three stages. In the usual two-stage type there are three revolving disks for the first stage, with one set of nozzles; steam then passes to the nozzles of the second stage, which is larger in diameter and has longer buckets of different pitch than those of the first stage. Expansion in the high-pressure nozzles is from boiler pressure down to about atmospheric pressure, while in the low-pressure nozzles expansion is down to vacuum. In the low-pressure, the nozzles and stationary members are placed throughout the circumference of the casing, while in the high-pressure there is but one set of nozzles.

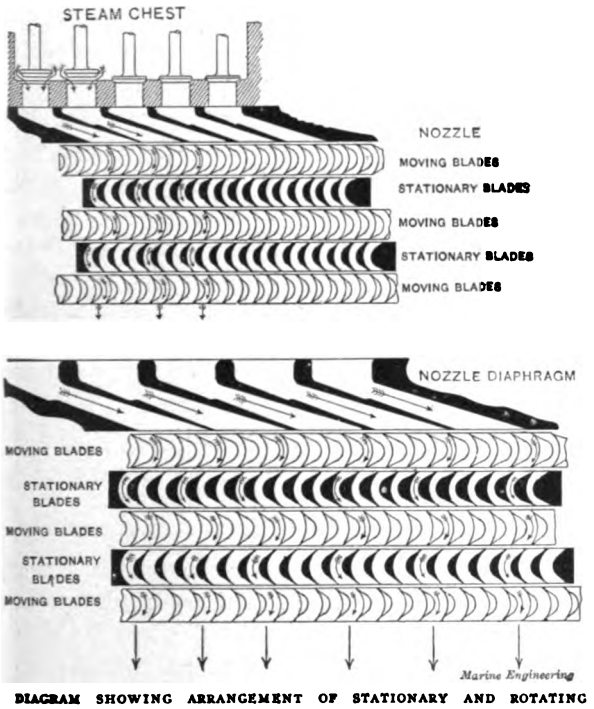

DIAGRAM SHOWING ARRANGEMENT OF STATIONARY AND ROTATING BLADES ON THE CURTIS TURBINE.

One of the chief points of interest in this turbine is the unique form of regulation. A nozzle is designed to work with maximum efficiency under one set of conditions, viz., volume and pressure. Should these be changed through throttling the efficiency is greatly reduced. In this turbine the nozzle is either wide open or closed in the high-pressure chest. Regulation is by an inertia governor, placed on top of the shaft, which, through electrical contacts, will close or open one or more nozzles as the load decreases or increases; thus each nozzle is running at its maximum efficiency.

By the use of superheated steam the efficiency is greatly increased, which is doubtless due to re-evaporation of the water of condensation which may take place in expansion.

The rights of the Curtis turbine for electric-power generation are owned by the General Electric Company, and the form of turbo-generator is illustrated on page 430. The generator and turbines are mounted on the same vertical shaft, which is supported under an oil- or water-cooled step bearing; the liquid being forced in under pressure, the clearance between the revolving and stationary members is small, but leakage is slight, as there is but slight difference in pressure between the steam-jet and casing pressure.

The generator is placed at the top, the high-pressure is next below, and valves for opening and closing the nozzles may be seen just above the steam connection. The low-pressure with removable segmental casing is seen adjoining below. The exhaust is taken to surface condenser, at the back of the picture. The governor is mounted on top of the shaft and the rod for operating the valve is shown in the view.

At present the General Electric Company states that it has altogether machines of 300,000 K. W. under contract for driving electric generators. The largest is 7,500 K. W.; others are 5,000 K. W., 2,000 K. W., and 500 K. W. In point of size these turbines are about one-twentieth that of a reciprocating engine with its generator, with about one-eighth the weight, exclusive of foundations. Running at a high speed, 1,500 R. P. M. for a 600-K. W. size, permits of a much smaller generator. The efficiency curves, published by the company, give a water rate with saturated steam of 19 pounds per K. W. at full load. With steam superheated 150 degrees Fahrenheit the water rate is reduced nearly 21-2 pounds per K. W. The efficiency gradually decreases with increased steam pressure from 21 pounds of water per K. W. at 107 pounds steam pressure (gage) to 18 1-2 pounds at 200 pounds steam pressure. This is with saturated steam. The curves of water rate with saturated steam and with different vacuum pressures show a marked increase in economy for high superheat and low vacuum.

This type of turbine is doubtless capable of several different applications. The marine type has already been experimented with, and for the last year and a half the steam yacht *Revolution* has been in service equipped with this turbine. Of course, the machine is mounted on a horizontal shaft forming part of the line shaft. About 2,000 horse power has been developed on this boat when running at 700 revolutions per minute. The great objection to former types of turbine for marine propulsion has been the impossibility of reversing without installing separate turbines. In the Curtis this objection is overcome by placing on the shaft a separate disk with blades reversed from those of the go-ahead type. In a later article MARINE ENGINEERING trusts to present the marine type to its readers.

Heating Value of Alcohol.—At the official laboratory of Austria some new experiments have been carried out on the relative heating value of gasoline and denatured alcohol. For motive purposes a pair of nominal 8-horse-power engines, one designed for alcohol and one for gasoline, were compared. The gasoline had a specific gravity of 0.7 and a calorific value of 7,700 calories per liter; the consumption per horse power was 340 grammes. The alcohol was of 90 per cent. strength and had a calorific value of 4,900 calories per liter; its consumption was 373.5 grammes per horse-power hour. The efficiencies were, therefore, 16.5 per cent. for the gasoline and 28 per cent. for the alcohol.

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INCREASE in the size and power of ships has usually gone forward with relatively small steps. The gradual development during the past 15 years, or covering the period from the *Majestic* and *Paris* class to the *Deutschland* and *Kaiser Wilhelm II.*, has been by steps of only a few thousand tons in displacement and a few thousand I. H. P. in power. In all such cases, and throughout the development covered by this period, the steps have not been so great but that the new ship might be fairly said to be in the same general class with her predecessors, and her general relation to the conditions of service might be fairly predicted by a simple extension of the qualities of the ships immediately preceding.

This is not altogether the case with the new Cunarders which are at present exciting so much interest in the maritime world. These ships as projected represent so long a step in advance of anything at present afloat that they can hardly be considered as belonging in the same class. The increase in length, beam, and displacement is not so extreme. A length of 760, beam of 85, and displacement of 35,000 tons means an increase of some 60 feet in length, 10 feet in beam, and 5,000 tons in displacement. These are not so great as to take the ships quite out of existing types. In power and speed, however, the increase is much more pronounced. A total I. H. P. of 70,000 represents an advance of some 30,000 beyond the front rank of existing practice. Likewise speed, which has crawled upward by fractions of knots, here takes a step of two or three knots. A trial speed of 26 knots and a sustained speed of 25 means an enormous advance in this respect—a step indeed corresponding to the advance in power, as already noted. In connection with the question of dimensions it is interesting to note that the earlier designs all contemplated a beam of some 76 to 78 feet, and it was not until these models had been subjected to tank experiment that it was decided to increase the beam to 85 feet, as noted above.

With these advances beyond existing ships it may be questioned to what extent the relation of the qualities of the ship to the conditions to be met in service can be satisfactorily predetermined. Mere size and speed are, of course, not to be considered as ends in themselves. There are also questions of harbor and terminal facilities, the maintenance of channels, and in general the problem of terminal navigation, all aspects of which present increased difficulties with increase in size.

Again, speed should have some reference to the length of route and proposed schedule of sailing, in order that the times of departure and arrival may both be in daylight. On a 2,800-mile run a speed of 25 knots would require 4 days and 16 hours, which might or might not fulfill this requirement, depending on the time of sailing. All this, however, has doubtless received full consideration, and the company will undoubtedly know how to use such ships to the best advantage. So far as the general qualities to be expected from increased size, the four of most importance are probably: the increased economy with which high speed may be attained with increase in size; the increased economy with which freight may be carried with increase in size; the general increase in steadiness and comfort for the passengers; the increasing regularity in speed and the possibility of a nearer approach to a regular schedule of time for arrival as well as for departure.

Regarding the attainment of high speeds, it is well known that below a certain size the attainment of a given speed is impracticable, and,

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in fact, the realization of a given speed imperatively calls for at least a minimum size. In the present case it is understood that the size was a more or less direct outcome of the condition expressed in terms of speed. Along the same line it follows that for a given speed the minimum size is required before any freight whatever can be taken. Beyond this point the proportion of freight to total displacement rapidly increases, and the expense decreases in corresponding proportion. The increasing steadiness and comfort are qualities of which it is difficult to express the money value, but the value is none the less real and will go far in determining the choice of route or the price which the passage will bring. It is too much at present, in any event, to hope for any great regularity or approximation to a schedule in arrivals at port, but in fair weather and with ships of this size a much nearer approach may be looked for than with ships of present-day size.

The design and construction of these ships is a project of great independence and boldness and one which will be watched with the greatest interest by the entire maritime world. Time alone can determine whether the combination of characteristics is such as to render them to the best possible degree suited to the commercial and economic requirements of the next few years.

ELSEWHERE in this issue will be found a description of a new type of turbine of which until recently but little has been generally known. The Curtis turbine has been the subject of experimentation for several years past, but now it is being sold commercially for the purpose of electric-power generation. The advantages of the steam turbine over the reciprocating type of engine are, as has been previously stated in these columns, very many. First in point of design is the simplicity of the machine, free from reciprocating parts or packed joints; then, because of the high speed of revolution, its size and weight are greatly reduced. A uniform turning moment on the shaft, resulting from the constant flow of steam through the nozzles, reduces vibration to a minimum. Second is the economy which is possible with this form of engine using superheated steam. The degree of superheat in reciprocating machines where lubrication is required is limited; but in the turbine the superheat may be carried to a point only limited by the form of the generators. Superheat prevents condensation due to the expansion of the steam or from radiation, and the marked increased efficiency with superheated steam, as shown in the curves published by the various makers, is accountable from the fact that the friction between the turbine revolving at such very high peripheral speeds and its surrounding medium varies according to the density of said medium. Recalling that this type of engine was introduced but a very few years ago, the extent of its present use is almost phenomenal, and its ultimate successes and replacement of the reciprocating engine in certain fields is assured. Many of the problems have already been solved, and engineers throughout the world are at work to perfect the present machine. It is eminently suited for small-plant work, for the economy of a small turbine is expected to be practically as good as that of the large machines, which is not the case with reciprocating engines. Gradually we see that specific types are being evolved for the various purposes, and already the Parsons turbine is commercially used with success for ship propulsion. Absence of vibration especially recommends the turbine for this service, and though the progress in this line has not been marked with such swiftness as it has in stationary work, possibly because of the conservativeness of marine engineers to adopt any fundamentally novel machine, we may confidently look for marked changes in the type of engines in our merchant and naval vessels.

NO doubt those interested in marine engineering will read with interest the series of articles on "Electricity on Shipboard," the second chapter of which appears in this issue. The fact that practically all marine installations have been made in the last twenty years is one scarcely realized by the present-day engineer. The development of the electric plant on board ship, especially in naval work, has been most marked. At first electricity was used simply for lighting and on the low-voltage system; now single installations of several sets, amounting to over one thousand kilowatts capacity, are found on our large warships, electricity being used for operating all ammunition hoists, turning the turrets, and for many auxiliary purposes. The writer of these articles, from the great fund of information at his command and his long experience, is well qualified, not only to record the past and present practice in this field, but to give much of practical value to this constantly-developing subject.

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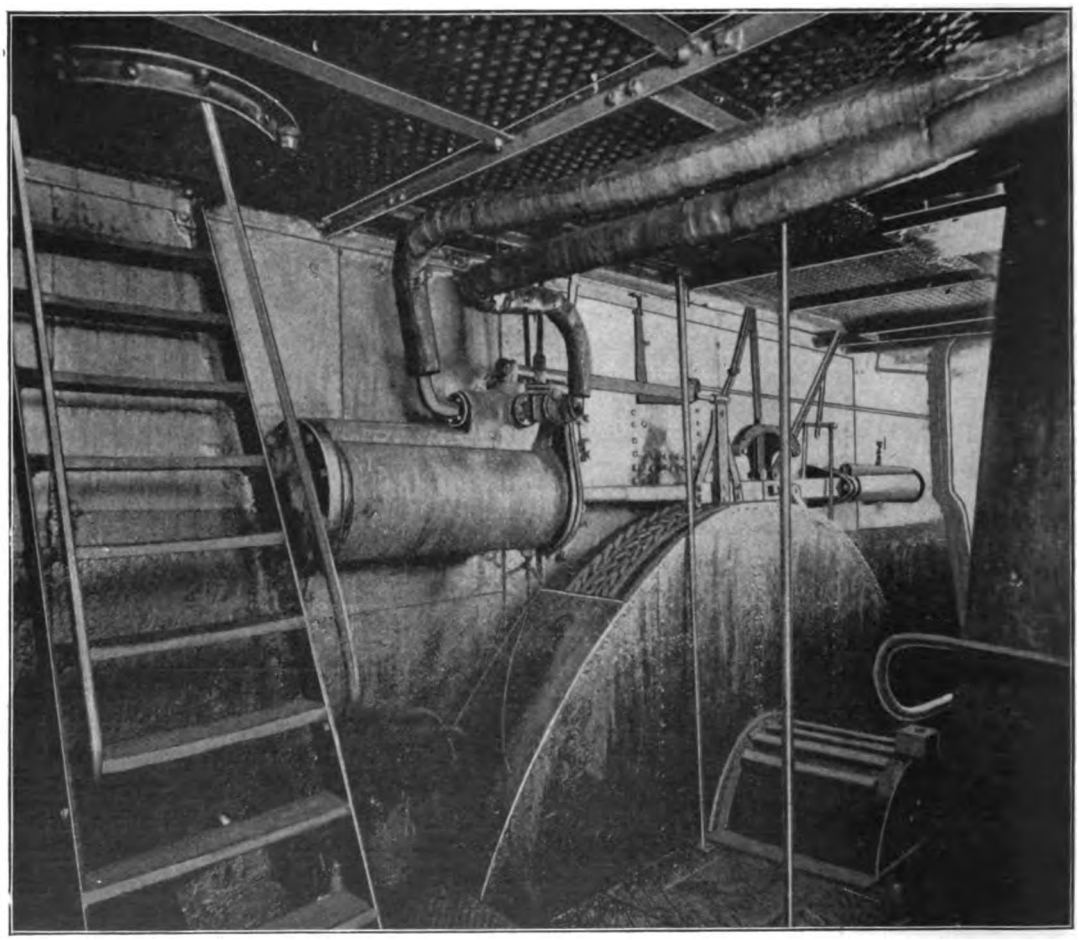
A Curious Old Ship.

A freight and passenger steamer, running from the port of New York, built in 1874 at Newcastle, England, combines some interesting and quaint ideas of engineering and shipbuilding. In the first place, the ship is one of those long, narrow vessels with no steel superstructures, her general dimensions being: length, 350 feet; beam, 37 feet (giving ratio of length to beam of 9 1-2 to 1); and 27 feet 8 inches deep. She has seen long service in her trade, but her last voyages have been run at a speed equal to that made when she first came out.

Continuing aft is the engine-room casing of wood, and at the stern is a long deck house, a dining room for the first cabin, the other accommodations being on the deck below. This dining room is curiously trimmed with white marble panels and pilasters. The stairway at the forward end of the house leads down to the above-mentioned rooms, and is fitted with cast-iron railing and posts.

It is in the engine room, however, that one finds the most interesting features of the "curiosity shop." Here is a steeple-compound engine with cylinders 35 and 76 inches diameter and 51 inches stroke. The high-pressure is mounted on top of the low-pressure, both cylinders having slide valves on the forward sides. A few steps down from the deck land one on the upper grating, and from the second grating the engine is operated. Two eccentrics give motion to the low-pressure valve, which has a through-stem to which is attached a rocker arm for operating the valve of the high-pressure. Reversing is accomplished by a steam cylinder laid vertically on the starboard engine column, and the throttle valve is within reach. The valve stem of the low-pressure is guided below the eccentric block, thus requiring very long-forked eccentric rods. The engine is mounted on cast-iron columns, one front and one back, in the latter of which is built the condenser



FLYWHEEL AND TURNING GEAR ON AN OLD MARINE STEEPLE-COMPOUND ENGINE.

Stepping on the main deck one is struck by the absence of poop, bridge, or forecastle, there being a clear deck from stem to stern, the only obstruction being wooden deck houses amidships and aft. Amidships, on either side, is a teak house with quarters for the officers, and on the center line amidships is a galley. Aft of this is a donkey boiler and the fidley grating and stack. The boiler is mounted in the open (in fact, there is no deck extending over from the side houses, except the bridge), and is of the cylindrical type, fired from the starboard end; its stack is led up along the forward side of main stack. The bridge is on the top of the galley at the forward end of side housings, so it is evident that it is not a very dry spot in rough weather.

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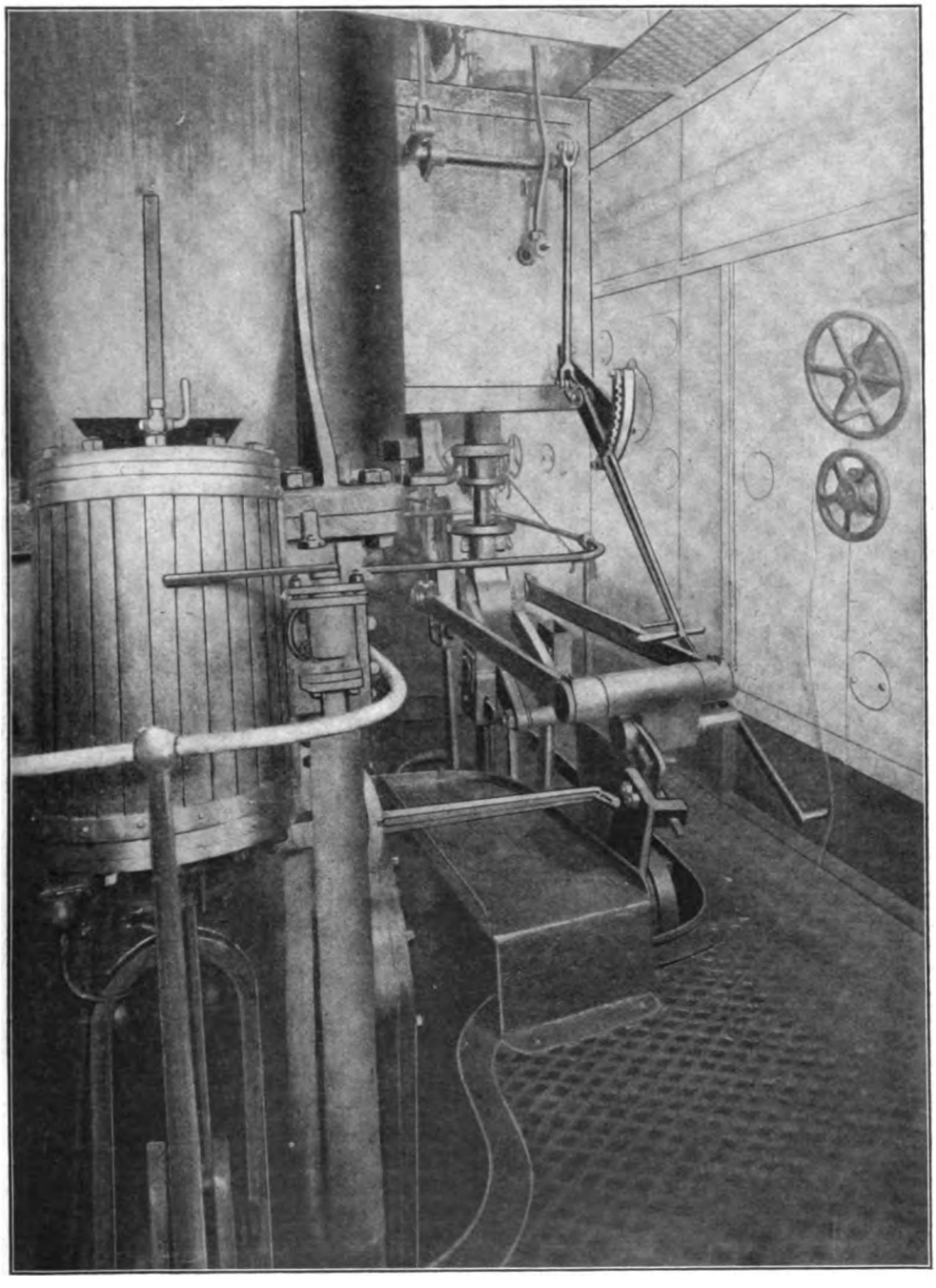
Steam is carried through a jacket on the low-pressure into the column to the condenser.

At the after bulkhead are three levers coming up from below, which bear inspection and can be better seen from below. Descending the ladder to the engine-room floor, we find the most curious feature of the whole ship. Here is a flywheel, about 10 feet in diameter, on the main shaft just forward of after engine-room bulkhead, used to steady the motion and also to be called in service when the engine stops on a dead center. On the face of the rim of this wheel are cut three sets of ratchet teeth, two in one direction and one in the other. Close above the wheel runs the piston rod from a long-stroke horizontal cylinder, and from this rod may be dropped, by the above-mentioned levers, two pawls, one for engaging either set of ratchet teeth. To get the engine off the center the method is thiswise: If going ahead, the lever controlling the ahead pawl is lowered, the valve on the steam cylinder placed for driving the piston rod to the starboard side, and the steam is turned on; the action of the piston rod will pull the pawl and the wheel over, and thus the crank



VALVE GEAR ON A STEEPLE-COMPOUND ENGINE. THE REVERSING CYLINDER IS SHOWN AT LEFT.

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will be brought off center. If stern motion is desired the other pawl is engaged and the steam piston reversed. To get into the shaft alley one climbs down a ladder through the after bulkhead from the upper platform. In place of the usual carefully-designed and more or less complicated thrust bearing, it requires some search to find the thrust block at all on this antiquated type. Close inspection reveals it at the after end of the main journal. It consists of a brass ring with white metal face, pinned to the forward face of crank-shaft coupling, and bearing on the after end of the main journal. The ring is well lubricated. The outside diameter is 20 inches, while the diameter of the shaft is 14 inches. Thus the thrust surface of the engine, which indicates about 1,400 horse power, is but 160 square inches. The engine averages 58 turns. There is no special thrust surface fitted for going astern. The connecting rod has straps at both ends, the lower end being held by two bolts and one key, while in the upper cotter there are two keys. The eccentric rods also have straps at the upper ends.

The air, circulating, bilge, and feed pumps are driven by levers and double links on the crosshead. The other pumps are vertical, with cast-iron standards with flywheels attached.

Passing through from the engine-room bulkhead door one descends several steps to the boiler room, where there are two double-end, return tubular boilers, two furnaces at each end with a common combustion chamber to all four furnaces, fitted with vertical Galloway tubes 14 inches in diameter. The boilers, though built thirty years ago, are in good condition. In 1888 they were fitted with Howden system of forced draft, and now supply steam at 120 pounds pressure.

In view of modern-day practice, it is almost astonishing that such an engine can be run with any profit to the owners, but recently, on 10,000-mile voyages, the coal consumption, for all purposes, has been but 1.8 pounds per I. H. P. The engine runs well, and has required very little repair since the day it was built. One cannot but be struck with the skill and ingenuity of the engineers of the last decade, when he sees such a well-built machine, which has been in constant service for so many years, and when he realizes the disadvantages of tools and material under which the engineers of that time worked. J. W. M.

Novel Launching Ways.

Editor Marine Engineering:

The accompanying photograph may be of interest to your readers as representing an economical and convenient way of launching small craft. The view represents the second of two similar boats built by the Victoria Machinery Depot Company on its own wharf, which has a deep-water frontage and an elevation of 9 feet above normal tide level. Both boats were launched direct from their berths over ways, with the end extension carried over a floating scow 24 by 85 by 5 feet, which was made to serve both boats by simply shifting sideways and lining up with upper end of ways for second boat.

In arranging for the launches the scow, which has two solid longitudinal keelsons, was given initial displacement by partial flooding with water, and trimmed to suit with cast-iron ballast at outer end. To allow for the 4-inch calculated additional submersion due to the launching weight of 30 tons represented by boats, the fixed ways on wharf, which were of 10 by 10-inch lumber, were carried 10 feet over scow beyond the face of the wharf, and were securely dogged to the sills, and at launching the tide was allowed to rise about 2 inches over the level required to bring ways on scow in alignment with upper portion, the inclination in this position being 7-8 of an inch to 1 foot.

This gave such good results in case of the first boat and showed so little disturbance of grade that with the second boat, owing to the tide being late, the boat was launched when the scow was very little more than up to required level. The spring of the 10-foot projection, combined with the speed of boat, gave all the necessary elasticity for passing smoothly over the joint.

LAUNCHING A BOAT ACROSS A BARGE.

Apart from above, the boats themselves have a certain interest as being the first contracts of the kind let by the British government to a local firm, and are also the first steel boats laid down and built in this province The boats are specially intended for laying submarine mines and are of the standard type used by the Imperial War Office for that purpose. The following are some of the particulars: Length between perpendiculars, 50 feet; breadth, molded, 93 feet; depth, molded, 5 feet, displacement, working condition, 45 long tons; shell plating, outer, 5-16 of an inch; inner, 1-4 of an inch. The fore part, including fore foot, is sheathed on outside with 1 1-2-inch teak. Internally hull is divided by 3 water-tight bulkheads of 3-16-inch plate, and on deck forward are fitted a power-operated crane and other special appliances for handling mines and cables. The machinery consists of a single-furnace, Scotch marine boiler, 6 feet 3 inches diameter by 6 feet 9 inches, to

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work at 120 pounds pressure, with a twin set of fore-and-aft compound engines, 6 and 12 inches diameter by 8 inches stroke, arranged to run at 260 revolutions and develop 90 indicated horse power. In addition there are one independent condenser and set of pumps. All piping is of copper, and work in this and deck department is all finished in regular naval style.

G. H. HARDIE.

QUERIES AND ANSWERS.

Q. 158.—Will you please inform me whether the crank pin stops at any point of its revolution?

A.—The only time that the crank pin would stop would be when the engine comes to rest. The angular velocity is supposed to be the same throughout the revolution, but, as a matter of fact, there is slight difference in the speed in one revolution; that is, angular velocity. Possibly you have this confused with the crosshead pin, which comes to rest at the end of each stroke or on dead center.

Q. 160.—Will you please tell me in your paper in what respect does the license of an engineer in a gasoline boat for 15 tons differ from that of a steamboat? C. E. P.

A.—By applying to your local U. S. Steamboat Inspector you will doubtless find that the qualifications for obtaining a license for a gasoline boat above 15 tons depend altogether on your experience and ability. There is no set length of previous experience required, as in obtaining a steam license.

Q. 161.—Will you please answer the following in your Queries and Answers column:

Given a vertical compound marine engine to design, 500 indicated horse power, 100 revolutions per minute, 150 pounds boiler steam pressure:

(a) Please show method and reasons of obtaining diameters of cylinders and stroke.

(b) Also give sizes of cylinders and stroke if the above were a 3-cylinder triple.

A.—In proceeding with a design along these lines it is first necessary to decide on the number of expansions for the steam. For a compound marine engine with steam pressure as stated, from 6 to 8 expansions are usually provided for. Let us take 7 in the present case. Then the mean effective pressure which may be expected, reduced to the l. p. piston, will be given by the usual expansion formula:

$$p_m = f\left[p\left(\frac{1 + hyp.\ log\ r}{r}\right) - p_b\right]$$

From a handbook we find the value of hyp. log 7 to be 1.946. We then find for the value of the parenthesis .421. Then remembering that p is the absolute pressure = boiler pressure plus atmospheric = 150 + 15, or 165, and taking for the back pressure in the condenser, p_b, a value of 3 pounds, we find for the expression in the square brackets:

$$165 \times .421 - 3 = 66.5.$$

This would be the reduced mean effective pressure if there were no losses due to wire-drawing, etc., as shown by the rounding off the corners of the cards. To provide for this the factor f is introduced. Its value with compound engines is usually between .70 and .80. In the present case we may assume a value of .75, which would give for the probable reduced mean effective $.75 \times 66.5 = 50$ pounds.

We then turn to the usual horse-power formula:

$$H = \frac{2\,pLAN}{33{,}000}$$

from which we find:

$$A = \frac{33{,}000\,H}{2\,pLN}$$

In the present case we have $H = 500$, $N = 100$, $p = 50$, while L = length of stroke and A = area l. p. cylinder are unknown. We must, however, make an assumption in order to make progress, and we will therefore take $L = 30$ inches, or 2.5 feet. Then, substituting, we have:

$$A = \frac{33{,}000 \times 500}{2 \times 50 \times 2.5 \times 100} = 660$$

whence diameter = 29 inches. This result shows that the value of the stroke was taken too large. As a second trial we may take 24 inches, or 2 feet. Solving similarly we shall find $A = 825$ and diameter = 32.5. This will presumably do very well for the l. p. cylinder, and we must next determine a suitable size for the h. p. To this end we first note that a cut-off at about .60 will give, taking the clearance into account, an expansion of not much over 1.5 in the h. p. alone. Now altogether we must get an expansion of 7. One step or ratio of 1.5 we obtain in the h. p.; the remainder, or $7 \div 1.5 = 4.66$, we must obtain between the h. p. and l. p. Hence the area of the h. p. will be found by dividing that of the l. p. by 4.66. This gives for the h. p. an area of 177 and a diameter of 15. Hence, as thus determined, the engine would be 15 and 32.5 by 24, with revolutions of 100 per minute. This would give a well-proportioned engine, and, under the conditions assumed, would undoubtedly develop the power desired. If a higher grade of expansion were desired the dimensions would correspondingly vary. Without giving details it may be of interest to note that with a total expansion ratio of 9 the engine would be about 14.5 and 35.5, with revolutions and stroke the same as before.

With a triple-expansion engine the general mode of procedure is the same. A suitable total expansion ratio would be 10 or 11, a suitable value of f from .60 to .70, the resulting value of the reduced mean effective about 33, and with a stroke of 27 inches the diameter of l. p. would result 37.5. To find the h. p. we proceed as before. Take the total expansion at 10.5 and divide by 1.5, the probable expansion in the h. p. This gives 7 for the ratio between l. p. and h. p., or for the h. p. area $1104 \div 7 = 158$. This gives 14.2 for the h. p. diameter. Then for the intermediate diameter we may take the square root of the product of the other two, or $\sqrt{14.2 \times 37.5} = 23$. Hence, as determined, the engine would be, say, 14.25 by 23 by 37.5 by 27 stroke and 100 revolutions.

Official Numbers for United States Vessels.—A new system of official numbers for American vessels went into effect on July 1 when the Bureau of Navigation joined the Department of Commerce and Labor. The new series of numbers begins at 200,000, and hereafter new vessels will be numbered seriatim in the order of application for official number, regardless of the initial letter of the vessel's name and of rig or motive power. Thus the official number will indicate approximately the date of build of each new vessel hereafter, being permanently marked on its main beam.

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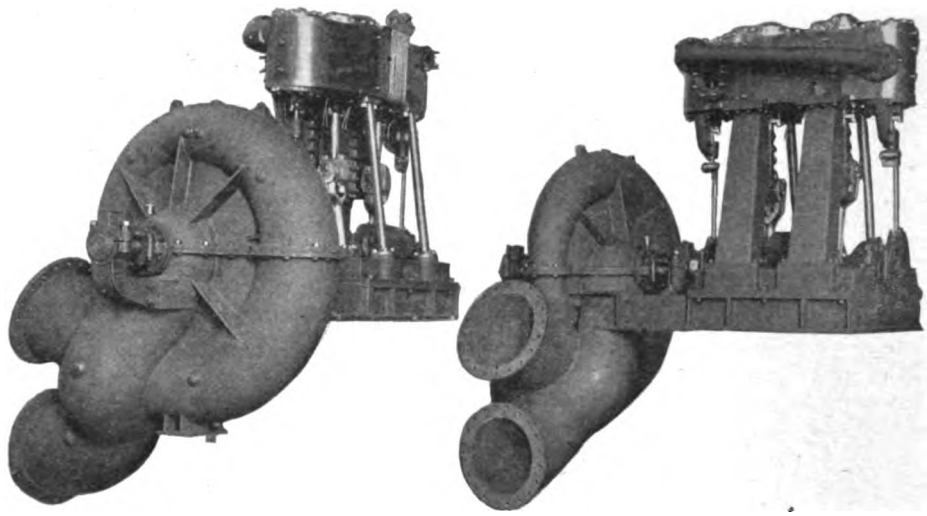
ENGINEERING SPECIALTIES.

Large Compound-Driven Circulating Pumps.

On each of the two Great Northern steamships building at New London, Conn., there will be installed two large condenser circulating pumps built by the Morris Machine Works, of Baldwinsville, N. Y. Each pump has a suction and discharge opening 20 inches in diameter. The pumps are of the double-suction type; that is, the inlet water is divided so as to enter equally on each side, thus the runner is perfectly balanced and there is no end thrust. The runner itself is of the enclosed type and is made of brass, which is the metal used for the casing also. The pump shaft is of manganese bronze and is carried on two bearings entirely outside of the pump, which is somewhat of a new departure with circulating pumps in this country.



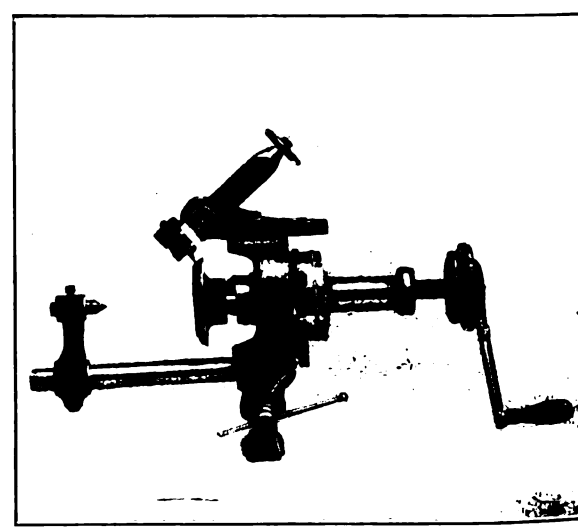
TWO COMPOUND-ENGINE-DRIVEN CENTRIFUGAL CIRCULATING PUMPS.

For ordinary service each pump is to deliver 8,000 gallons of water per minute, to do which the speed of the shaft will be about 200 revolutions per minute. However, the pumps are capable of considerable increase in this delivery by speeding up the engines, and as the engines themselves are built for 250 pounds steam pressure, and with very large wearing surfaces throughout, they are capable of being crowded to a great extent.

A cross-compound engine is directly connected to the pump shaft, the cylinders being 10 and 20 inches in diameter by 10 inches stroke. Both high- and low-pressure cylinders are fitted with piston valves, pistons being of cast steel. The crosshead pins are 3 inches in diameter by 4 inches long; crank pins 4 1-2 inches in diameter by 6 1-2 inches long; crank shaft 4 1-2 inches in diameter. As shown in the illustration, the pump and engine are mounted on a sub-base.

Patent Adjustable Disk-Cutting Device.

The accompanying illustration shows a device used to recut a valve disk with the Smith patent disk cutter. The ring supporting the cutter is held in a vise by a lug, the machine being attached to the ring by the chuck jaws. The valve disk to be recut is securely fastened to the small check or machine spindle and is given a rotary motion by turning a crank at the right. The pointed tool is at the same time fed slowly over the valve disk. With this machine all flat, oval, and taper valve disks, also check-valve disks up to 12 inches inclusive, can be recut. In the illustration the valve cut is oval shape. It will be seen that the top of pointed tool rests against the curved space of block, and that by feeding by means of the handle and screw the tool will travel in an arc, for there is a strong spring holding the tool against the shoulder. The block has two curves for cutting a valve with greater or less curvature; for cutting a disk at 45 degrees the block with the curve is replaced by one with straight edge, and then when the tool is fed it will travel in the path 45 degrees to the center line of valve. A flat disk may also be cut by turning the head around so that it will stand square to the center line of valve. These handy little tools are made by The Leavitt Machine Company, Orange, Mass.



ADJUSTABLE VALVE DISK-CUTTING DEVICE.

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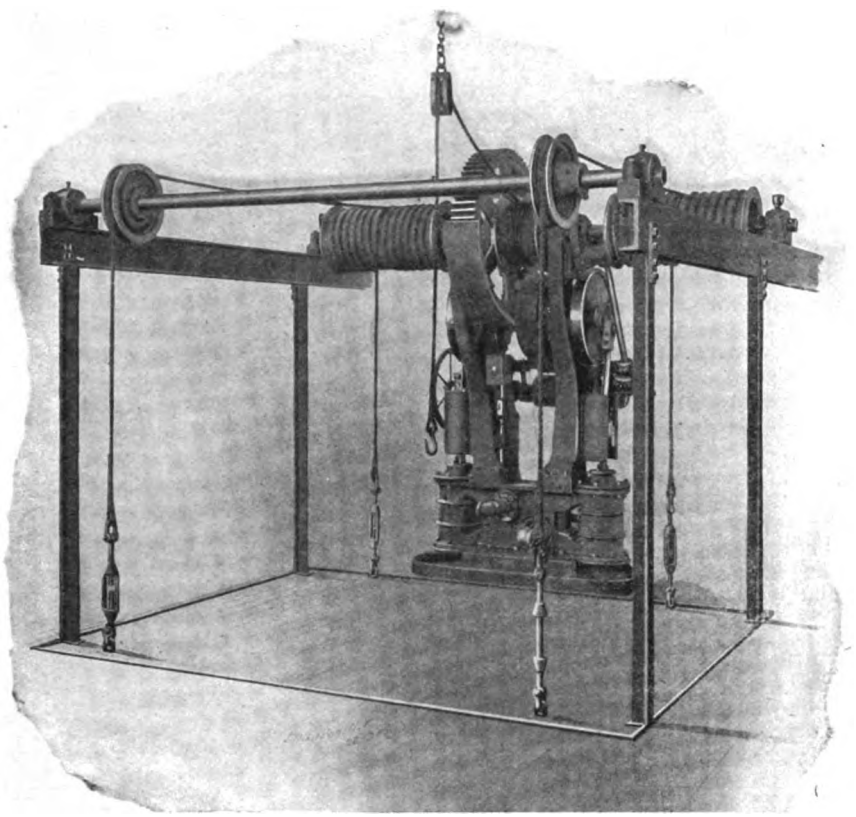
Elevators for Use on Board Ship.

Four elevators or hoists, such as shown in the illustration, have been installed on the steamship *Monroe*, recently built at the Newport News shipyard for the Old Dominion Steamship Company. These elevators are steam driven, each having a capacity of 4,000 pounds net load at a speed of 100 feet per minute. The size of the platform is 7 by 10 feet. The engine is fitted with an automatic device whereby at the beginning of a loading operation the platform is automatically brought to a stop when it reaches the lower deck, therefore not requiring an attendant, as is usually the case with all kinds of elevators.

It is intended that when the lower deck is completely loaded this device is to be readjusted, so as to stop the platform automatically when it reaches the next deck, and so on. When all the decks are completely loaded the platform is then lowered to the lowest deck and disconnected. The main winding drums are then thrown out of gear and the whip hoist, which can be seen in the illustration, becomes operative. The hatchway may then be filled with cargo by means of this auxiliary whip hoist. In unloading these operations are of course reversed.

These elevators are compact, simple, and strong in construction, and extremely economical in operation. Full particulars may be had by writing the Otis Elevator Company, 71 Broadway, New York, N. Y.



STEAM-DRIVEN ELEVATOR FITTED ON BOARD SHIP.

Take-up Device.

The great trouble experienced when using the detent on the steam-engine indicator is that caused by the slack of the cord between the paper drum and reducing bushing on the wheel. This slack, if not properly guided when throwing on detent, is liable to get foul, thereby in many instances wrecking the instrument, or at least breaking the cord and causing delay and inconvenience to the operator.

The take-up device is designed to do away with this annoyance. It is simple in construction and can be applied to any standard indicator. It consists of a short horizontal arm with a vertical bearing at one end containing a steel pillar, on the upper end of which there is a frame holding a double set of loose steel rollers. Between these the cord from paper drum passes. On the lower end of the vertical pillar there is a light spiral spring enclosed. This spring causes the upper frame to revolve when the cord becomes slack, and is so arranged that the cord winds on frame, to be given up again when tension is applied.

The object of the device is to permit the operator to take as many cards as desired without unhooking from the crosshead or stopping the engine, no matter what speed. This of course pertains to indicators that are fitted with a detent and using a direct-connected reducing motion. Where an indicator is used in connection with other forms of reducing motions not so

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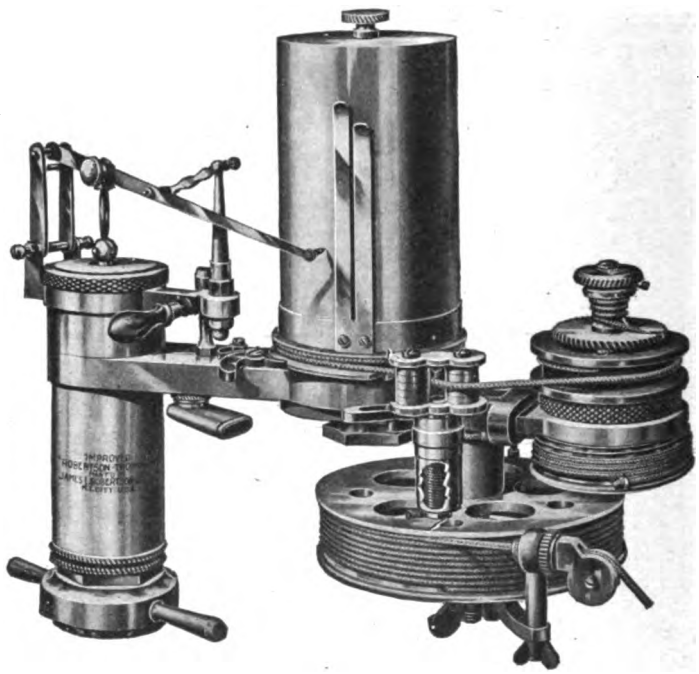
much trouble arises, and generally a rubber band is employed to take care of slack cord, which works fairly well. For this case the take-up device is made in the shape of a regular guide pulley to connect to indicator.

It may also be used with satisfaction as a guide pulley alone. Immediately the detent is engaged, it picks up instantly whatever slack cord there is. The tension of the spring in this device being so much weaker than the drum spring, as soon as the detent is disengaged the cord is instantly released and drawn out taut and assumes its regular position. The device is strong, well made, compact, and makes a very attractive attachment. It is good for any number of revolutions and is designed to fit all standard indicators and reducing wheels, or it can be made as a special fixture. Further information may be obtained from the manufacturers, James L. Robertson and Sons, Fulton street, New York, N. Y.



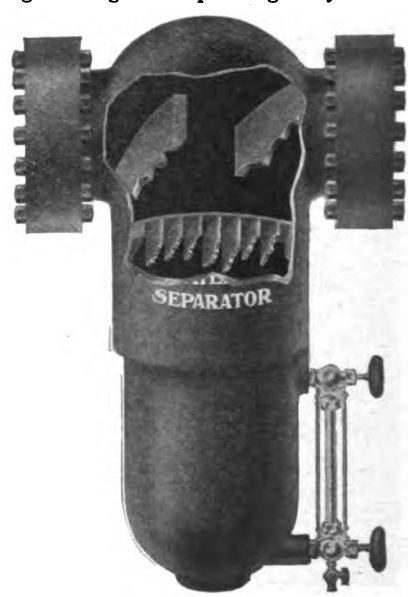
A TAKE-UP DEVICE FOR INDICATOR CORDS.

The Greenaway Separators.

The use of separators is daily becoming more general in all steam engineering. Therefore, the advantages of the Greenaway separators, made by the Nash Regulating Company, Detroit, Mich., will be appreciated. These separators, for both the vertical and horizontal types, are made very strong to withstand a working pressure of 200 pounds per square inch. Much trouble has been experienced in obtaining a good vertical separator. The one illustrated, a 2 1-2-inch, type A, rated at 20 horse power, has been subjected to severe tests at the University of Michigan. When passing 698.7 pounds of steam at 79.3 pounds pressure, the quality of the steam discharged through the separator was 99.5, while the amount of water in the entering steam was 13.69 pounds, or 1.95 per cent. of the total weight. When discharging at excessive overload, the quality was but slightly reduced, thus showing a high efficiency for all conditions.

In tests of the horizontal type 869 pounds of steam were passed through the separator at a pressure of 99 pounds. The steam contained 17.39 pounds of moisture, or 2 per cent., while the discharge from the separator contained but .4 per cent. of water, *i.e.*, the quality of the discharged steam was 99.6 per cent.

The construction of each of these types is very simple. The deflecting plates are fitted as shown in the engraving. The efficiency is attributed to the following cause: that steam enters, strikes the deflecting plate, and, owing to the greater specific gravity of the entering water, the water continues on a straight line with the diagonal plate, while the steam, being lighter, flows through the opening and into the discharge pipe.



GREENAWAY HORIZONTAL SEPARATOR.

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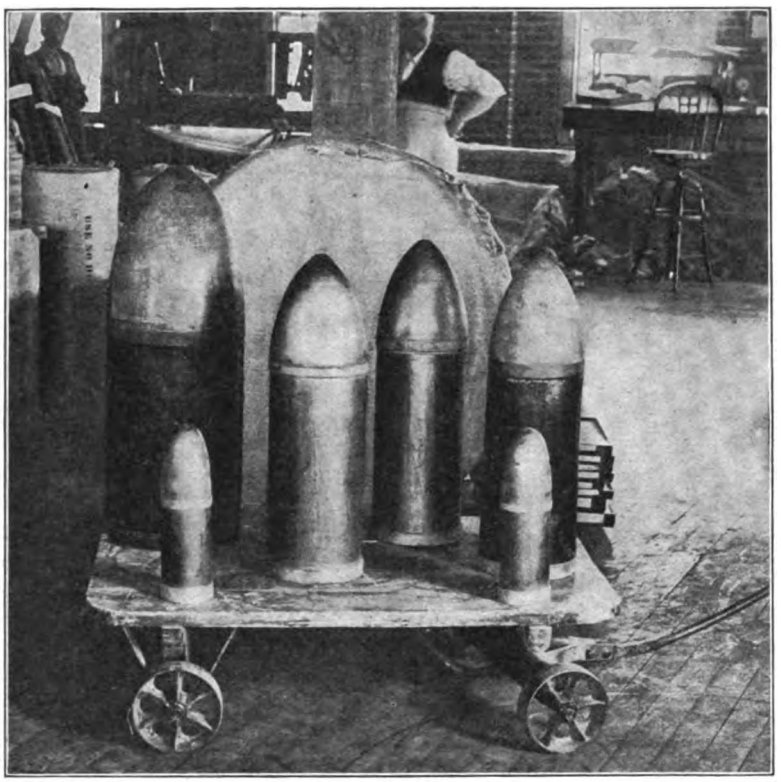
Rubber Shells.

An interesting illustration of one of the many uses to which rubber is adapted was recently given in Brooklyn at a public exhibition in the armory of the Thirteenth Regiment. The occasion was the review of the regiment by William Cary Sanger, Assistant Secretary of War.



RUBBER SHELLS USED FOR INDOOR TARGET PRACTICE.

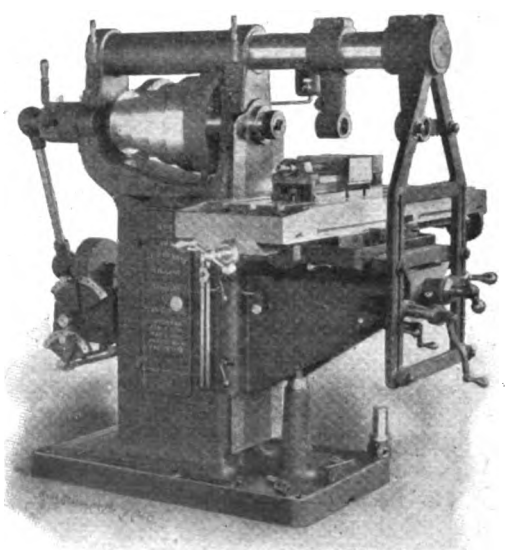
A novel portion of the evening's exercises consisted of artillery practice with 4-inch and 8-inch rubber shells. The squad in charge of the 4-inch gun succeeded in hitting the target almost every shot. The best shot of the performance, however—and indeed the best shot ever made in this kind of practice—was made by the squad in charge of the 8-inch gun, who hit a target consisting of a cartridge placed upright on the floor.

The difficult part of the construction of shells for this work was to get an article which would take the rifling of the gun without being soon cut up and destroyed, or fit so tightly as to destroy the progress of the shot on account of the friction. A number of experimental shells had been made previously, but they all failed in this point, being wabbly and so uncertain that one shot following another would hardly ever strike in the same spot. The present shells, however, are so successful that when a rifle is once aimed the shots will continue hitting the target one after the other, thus making practice work of real practical value.

The rubber shells, of which a photograph is here given, were made by the Voorhees Rubber Manufacturing Company, of Jersey City, N. J., which has made a reputation as a manufacturer of difficult specialties.

Fast Milling.

The milling machine is daily assuming a more important place in machine shops because of its large output. An interesting example of the speed with which the machines of the Cincinnati Milling Machine Company, Cincinnati, O., turn out work is illustrated in the accompanying engraving. The Cincinnati machine may



CINCINNATI MILLING MACHINE.

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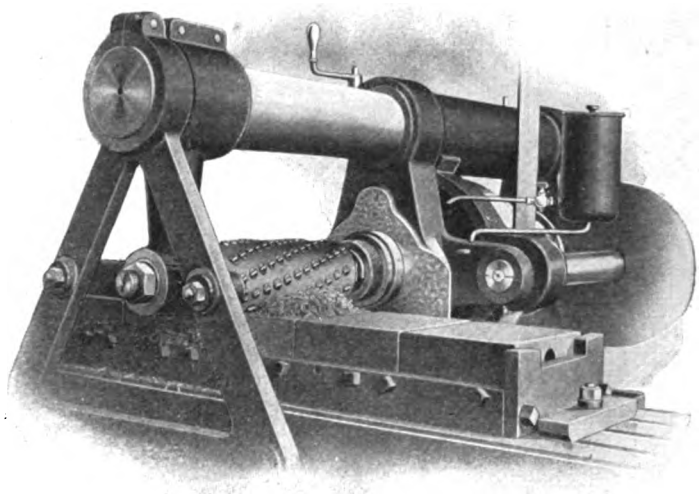
be used for all classes of work, such as milling irregular surfaces, engine frames, facing bosses, milling slots, or heavy spiral gearing, spindle shafting, etc., and all classes of vertical milling. The view shows one of these machines working a 4 1-2-inch diameter mill at a cutting speed of 40 feet per minute with a cast-iron surface 8 1-4 inches wide. The cut is 3-32 inch to an eighth of an inch deep, for the purpose of removing scale, and the feed is .252 inch per turn of cutter, which is equivalent to a table travel of 8 1-2 inches per minute. Or, in other words, cast-iron pieces 8 1-4 by 8 1-2 inches are surfaced in one minute, which it will be admitted is a high speed. In finishing work to close limits the proper rate of feed is determined by the foreman; but when a roughing cut is taken simply to clear off scale or excess of stock, or when a flat but not necessarily smooth surface is required, this machine may be driven at a speed as fast as the belts will stand. Thus by increasing the output of the machine the cost of the work is cut down, which in many cases is claimed by this company to be cut down to one-half.



FAST MILLING OF CAST-IRON SLABS.

A Remarkable Light-Weight Boiler.

The latest type of French destroyers, although of increased power and speed, carry, as most of the former boats, only two single-end water-tube boilers. In the *Arquebuse,* which has just been delivered at Cherbourg by Augustin Normand and Company, and in a number of similar destroyers, the two boilers are of the Normand type.

The speed trials, which took place after the ordinary eight-hour consumption trials and the preliminary runs on the measured mile, were of six hours' duration, one hour of which was at or above 24 knots, one hour at full speed, and the remaining four hours at or above 2.4 knots. In the one hour at full speed, 30.75 knots were attained with 320.38 revolutions per minute and 7,100 English I. H. P., so that each boiler furnished the steam necessary for 3,550 I. H. P. This is probably the record of power for one single-end boiler. No difficulty was experienced in keeping up the pressure.

The weight of each boiler complete, with fittings, stack, ash pit, fire bars, insulating covering, amounts to 19.2 tons without water, and 22.7 tons with water. The total displacement on trial was 299 English tons, including a dead weight of 68 tons, comprising only torpedoes and torpedo tubes, compressing pump, artillery and ammunition, provisions, water for boilers and crew, coal necessary for steaming 1,170 nautical miles at 14 knots (25.02 tons, as determined by the eight-hour preliminary trial), and 9 tons for sundries.

PERSONALS.

Stephen W. Baldwin will retire from the management of the New York office of the Pennsylvania Steel Company, Philadelphia, Pa. He will, however, retain his connection with this company in an advisory capacity of consulting engineer, with headquarters at 71 Broadway, the same as heretofore. Mr. A. E. Aedy, his first assistant for the last fourteen years, has been appointed to take charge of the New York office in the capacity heretofore filled by Mr. Baldwin.

George H. Gibson has resigned as manager of the advertising and publication department of the B. F. Sturtevant Company, Boston, Mass., to accept an appointment with the International Steam Pump Company, New York, N. Y. Mr. Gibson was formerly connected with the Westinghouse Company's publishing department, of Pittsburg, Pa., and was for two years a member of the editorial staff of the *Engineering News* of New York, N. Y.

Charles N. Crowell, who was formerly hull draftsman with the Townsend-Downey Shipbuilding Company, has accepted a position with the Snare and Triest Construction Company, New York, N. Y., and is at the League

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Island Navy Yard, where the company is constructing a plant for the government.

Clifton Lee, Jr., formerly with the Crescent Shipyard Company, has accepted an appointment as marine engine and boiler draftsman in the office of Inspector of Machinery, U. S. N., Bath Iron Works.

George Mattsson has left the Detroit Shipbuilding Company to take a position as chief engineer with the Canadian Shipbuilding Company, Toronto, Canada.

LAUNCHES.

Steamer Garden City.—The stern-wheel passenger steamer *Garden City* was launched at Snohomish, Wash., on June 9. The *Garden City* is the first steamer built in Snohomish, and is to ply between that city and Everett on the Snohomish river. She will be the type used in the Puget sound region. The principal dimensions of the *Garden City* are: length over all, 119 feet; beam, 20 feet; depth, 5 feet; with a speed of about 13 miles an hour. The *Garden City* was designed by Allen and Ballord, naval architects and consulting engineers, Seattle, Wash.

Steamer John O. Howard.—On June 21 the steamer *John O. Howard* was successfully launched from the yard of the Columbia Iron Works, St. Clair, Mich. This vessel is the third to be built at this yard. Her principal dimensions are: length over all, 241 feet; over keel, 224 feet; beam, 39 feet; depth, molded, 16 feet. She will be propelled by a triple-expansion engine, 16 by 26 by 44 inches with 36-inch stroke. Steam will be furnished by two Scotch boilers, 10 1-2 by 12 feet, at a pressure of 175 pounds. She will ply between Ogdensburg and Charlotte, on Lake Ontario, and will be equipped with special machinery capable of unloading her cargo within twelve hours. Her designed speed when laden will be 11 1-2 miles.

The Engineers' Strike.

The findings and award of the board of arbitration appointed to investigate and report on the case of marine engineers employed in tug and lighter service of the railways and terminals in the port of New York have been submitted. The arbitrators were W. I. Babcock and Thomas C. O'Sullivan and the umpire Andrew Fletcher, Jr. The settlement of the question of wages follows:

1. Engineers of boats having compound or multiple-expansion engines with low-pressure cylinder 36 inches or over in diameter, wages each, day $120 per month, night $115.

2. Compound or multiple-expansion engines with low-pressure cylinder under 36 inches in diameter, wages each, day $115 per month, night $110.

3. Single-cylinder engines, wages each, day $110, night $105. These rates to be flat.

The question of meals and payments for same was mutually agreed upon between each company and its own men; no reduction to be made in these rates when a boat is laid up for repairs or otherwise, if the engineer is retained on board. The owners are to allow cost of transportation to and from the regular reporting port of the boat. Two days off each month and one week's vacation each year shall be allowed each man without reduction of pay.

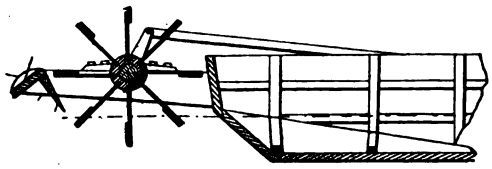
TECHNICAL PUBLICATIONS.

The Alternating-Current Transformer. By F. G. Baum, Stanford University. Size 8 inches by 6 inches. Pp. 195, with 122 diagrams and figures in the text. McGraw Publishing Company, New York, N. Y. Price $1.50.

This book is the development of a series of lectures given to university students, and is intended to present the main points of both theory and practice, especially as related to modern design. Some general acquaintance with alternating currents is assumed, but in general the treatment is such that the book should be read without difficulty by those for whom it was intended. There is a growing feeling among teachers of electrical science that the alternating current, as presenting the most generalized form of the problem, should be first studied, and that a thorough understanding of the phenomena of such currents will leave but little remaining with reference to the more special problem of direct currents. This book is written apparently in sympathy with this view, and gives in a clear and concise form the leading facts of theory and practice which relate to the particular field under consideration. For those familiar with the usual college mathematics the book should prove an interesting and valuable contribution to this field of engineering science.

SELECTED MARINE PATENTS.

730,889. BOAT. STEPHEN A. DUVALL, PENRITH, W. VA.



Claim.—The combination with a boat provided with paddle wheels, of a scraper secured to the rear of the paddle wheels and provided with a forwardly-inclined scraper adapted to have its lowest edge in close proximity to the blades of the wheel and slightly above the level of the water so as to cut off the water raised by said wheel, and a downwardly-inclined apron or top to cause the water scraped from the wheel to be converted downwardly. One claim.

731,020. PROPELLER FOR VESSELS. BERNT CHARLES, NEWARK, N. J. Four claims.

731,029. METHOD OF UTILIZING THE ENERGY OF WAVES. REGINALD A. FESSENDEN, PITTSBURG, PA. Seventeen claims.

731,110. BARGE-STEERING AND RETARDING MECHANISM. IRA H. LARR, SULLIVAN, IND.

Claim.—1. A fleet of vessels comprising a towing vessel and a line of following barges, steering and speed-retarding devices carried by each barge, and means for connecting such devices to the towing vessel.

2. A fleet of vessels comprising a towing vessel and a line of following barges, a steering device arranged at each side of each barge, and means for connecting all of the steering devices on the port side for simultaneous operation, and for connecting all of the steering devices on the starboard side for simultaneous operation. Five claims.

731,138. SKYLIGHT FOR VESSELS. WILLIAM B. STEARNS, MARBLEHEAD, MASS.

Claim.—1. In a skylight, the combination of a ridge having a gutter, a skylight hinged to the outer edge of said gutter having means for substantially closing the entrance to said gutter.

2. In a skylight, the combination of a ridge having a gutter provided with a pivot on which the skylight works, and a skylight having a hinged member which interiorly engages said pivot, and means connected with said hinged member which projects into and substantially closes the entrance to said gutter and works in said entrance as the skylight is operated. Six claims.

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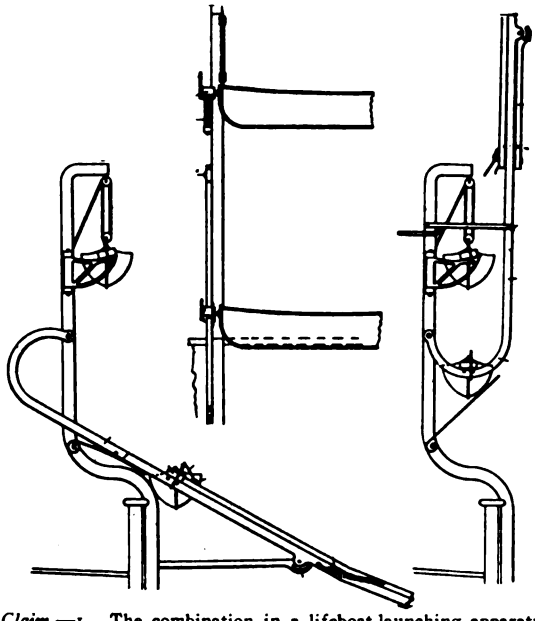
731,143. LIFEBOAT-LAUNCHING APPARATUS. SOLOMON H. URY, SAN LEANDRO, CAL.



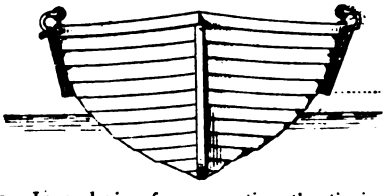
Claim.—1. The combination in a lifeboat-launching apparatus, of supporting and launching means, ways pivoted to said supporting means, bars hinged to the outer ends of said ways, spring connections between said ways and their respective bars by which the latter are normally folded over upon the ways, and shoes at the ends of the boat and engaging said ways, substantially as described, slidable upon the ways. Four claims.

731,491. TIDAL ELEVATOR. CLEMENT D. O'LEARY, PROVIDENCE, R. I. Four claims.

731,500. SUBMARINE-BOAT STRUCTURE. HERBERT N. RIDGWAY, WINTHROP, MASS., ASSIGNOR TO AUTOMOTUS BOAT COMPANY, BOSTON, MASS., A CORPORATION OF MASSACHUSETTS. Six claims.

731,514. PROPELLING MECHANISM FOR BOATS. MORRIS N. SHEEN AND DANIEL R. SHEEN, PEORIA, ILL. Seven claims.

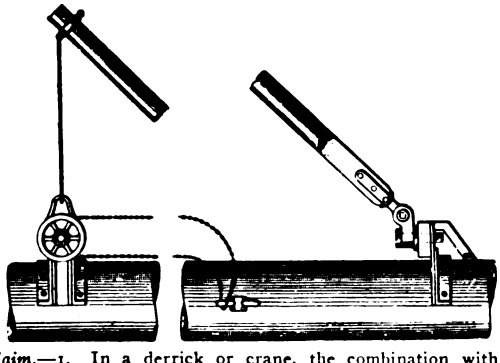
731,515. OUTRIGGER FOR BOATS. DANIEL R. SHEEN AND MORRIS N. SHEEN, PEORIA, ILL.



Claim.—1. In a device for preventing the tipping of boats, the combination of the boat, a collapsible air receiver secured to each side thereof and means for automatically opening and closing said receiver.

2. In a device for preventing the tipping of boats, the combination of the boat, a collapsible air receiver secured thereto, and means for automatically keeping the same close to the side of the boat when not in use, such means also adapted for opening the same when the boat is tipped. Five claims.

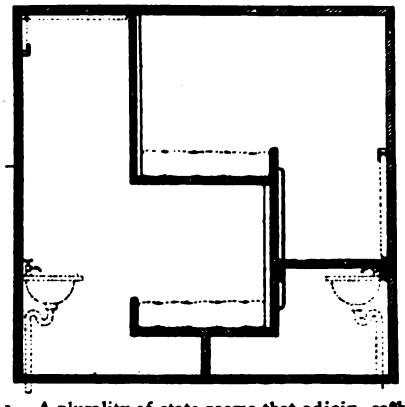
731,584. DERRICK FOR SHIPS. DUNCAN F. MACDONALD, GLASGOW, SCOTLAND.



Claim.—1. In a derrick or crane, the combination with the standard, of guides attached to the standard, a block arranged to slide between said guides, a jib having a head connected by a tie to said block, and means for moving said block laterally upon the guides. Four claims.

731,751. ALIDADE OR INDICATOR FOR SHIPS' COMPASSES. WILLIAM S. BURGESS, BOSTON, MASS. Three claims.

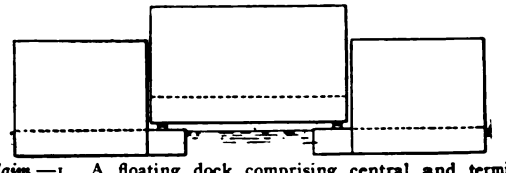
731,848. STATE ROOM FOR SHIPS. JOHN W. BOUGHTON, PHILADELPHIA, PA.



Claim.—1. A plurality of state rooms that adjoin, each having a berth therein, the berths being separated from each other, and means whereby the rooms may be placed in communication and the berths made common to both rooms.

4. In a plurality of state rooms that adjoin, a berth for each room, one berth being above and separate from the other, a movable vertical partition between the upper berth and ceiling, and a movable vertical partition between the two berths. 4 claims.

731,858. FLOATING DOCK. LYONEL E. CLARK, LONDON, ENGLAND.

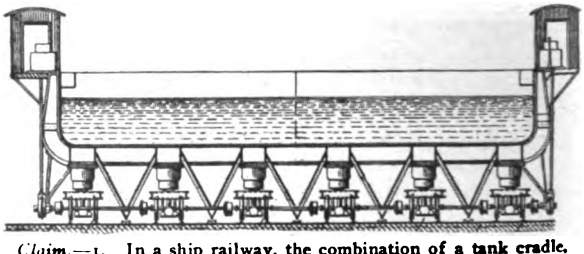


Claim.—1. A floating dock comprising central and terminal sections, each U-shaped in cross section, said terminal sections each having a tongue adapted to extend between the side walls of another section and rest on said section between said walls.

2. A floating dock comprising central and terminal sections, each U-shaped in cross section, and adapted to be securely fastened together to form a rigid structure, each terminal section having a projecting tongue adapted to enter between the side walls of another section, and each section of the dock being constructed with water-tight compartments, and having a lifting power such that any two sections are capable of lifting and supporting any one of the other sections. Two claims.

731,869. APPARATUS FOR REGULATING THE SPEED OF PROPELLER SHAFTS. THOMAS A. DUIFF, ROTTERDAM, NETHERLANDS. Three claims.

731,945. SHIP RAILWAY. OTTO PHILIPP, KÖTHEN, GERMANY.



Claim.—1. In a ship railway, the combination of a tank cradle, a framework for the same, pedestals on said framework, trucks for supporting said cradle, and pneumatic cushioning devices between said pedestals and trucks. Five claims.

The Cramp Loan.—The stockholders of the William Cramp and Sons Ship and Engine Building Company have approved the plan of board of directors to increase the capital stock from $5,000,000 to $6,250,000 and the bonded indebtedness from $1,800,000 to $7,500,000. Drexel and Company, the bankers who have underwritten the loan, will purchase a series of the shipbuilding company's notes to the extent of $5,000,000 with interest at 5 per cent. and maturing in annual instalments during a period of 20 years.

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Marine Engineering

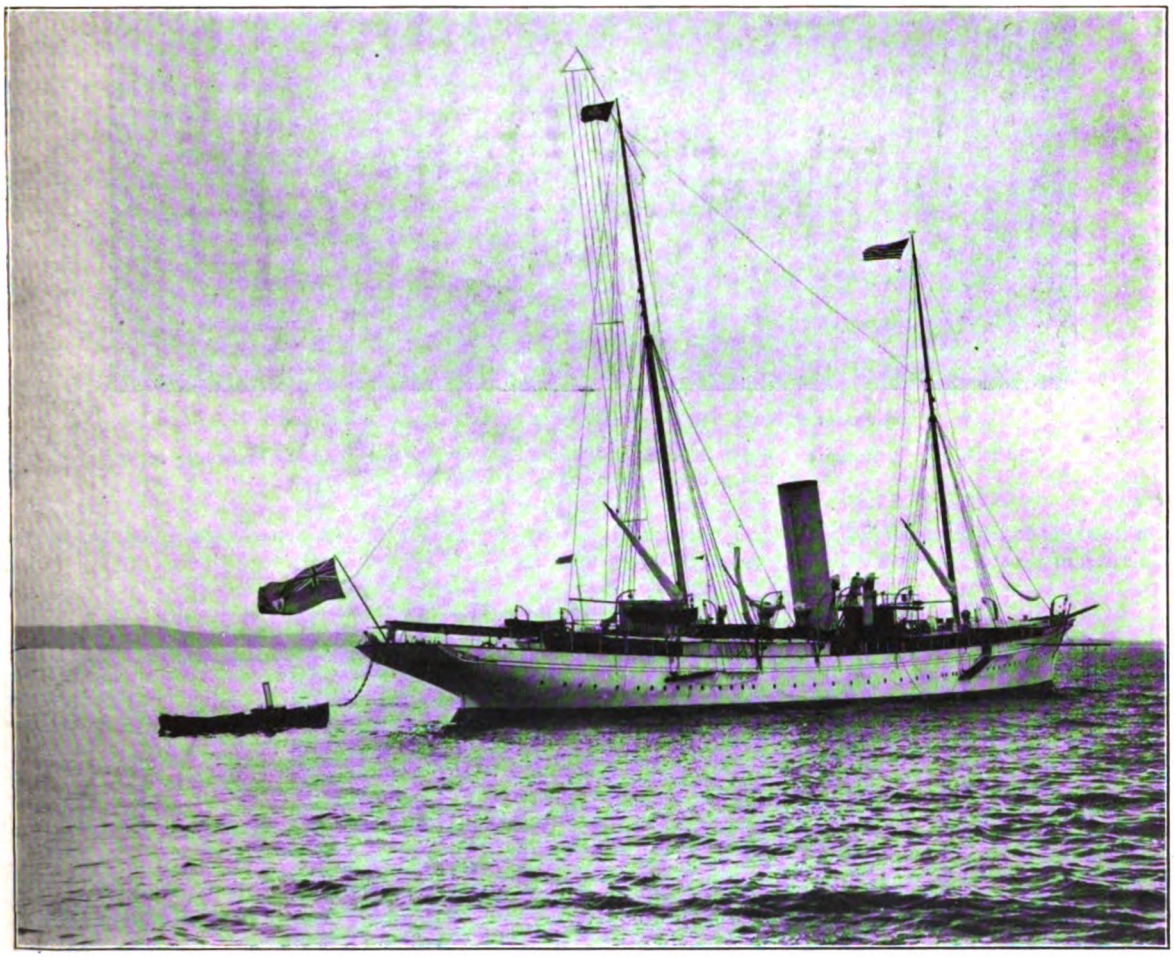
Vol. VIII. NEW YORK, SEPTEMBER, 1903. No. 9

DE FOREST WIRELESS TELEGRAPH ON THE STEAM YACHT ERIN.

The developments of wireless telegraphy, which have taken place in such rapid succession, have opened up an entirely new industry in the electrical field. It was only a very few years ago that Marconi published his first successful experiments in transmitting wireless telegraph messages, and to-day wireless systems of telegraphy are being commercially installed and used to a constantly increasing extent, and wireless telephony, which is now the subject of general experiment, may be expected to soon appear commercially.

It is for marine purposes, however, that these two systems are most eminently suited. Many former beliefs and theories as to the qualities and characteristics of the Herzian waves, such as the penetrability of mountains of the earth by this wave, have been exploded, and it is proved that the irregularities of the surface of the earth do offer resistance to the progress of this wave.

The greatest successes of any of the systems of wireless telegraphy have been attained at sea, and it is now generally believed that the wave front is perpendicular to its path and that it may be bent or distorted by geographical obstructions. It will, however, travel around the surface of the earth, regardless of the earth's curvature, for messages are constantly being sent or received between two points which are below the horizon from each other.



STEAM YACHT ERIN, EQUIPPED WITH THE DE FOREST WIRELESS TELEGRAPH.

[Photograph by E. Muller.]

(Copyright, 1902, by Marine Engineering, Inc., New York.)

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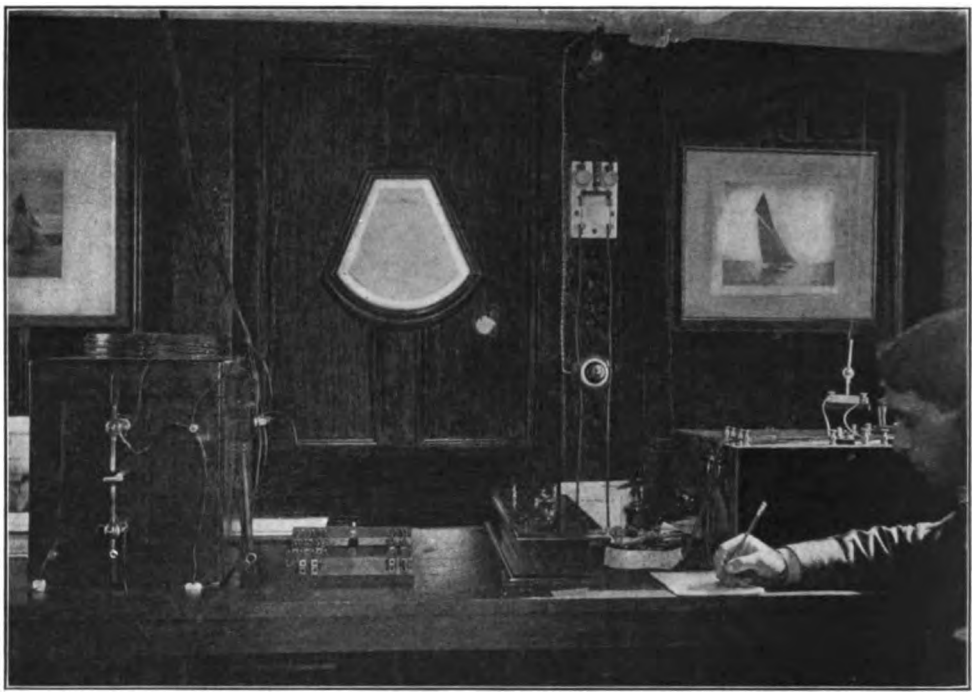
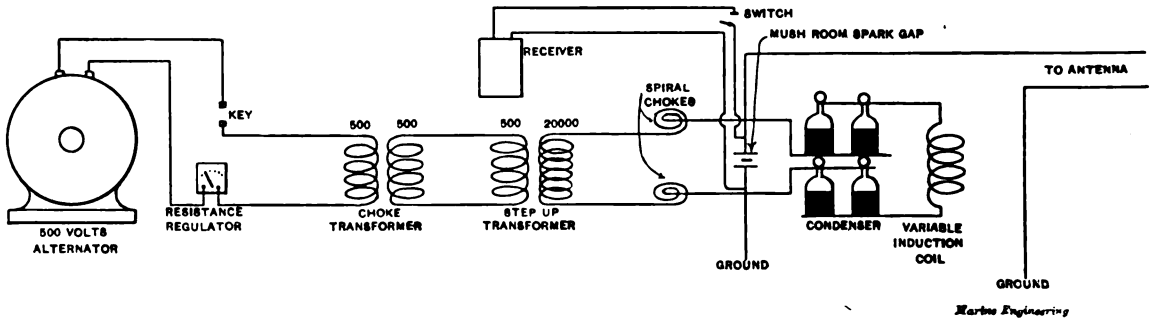
Many of the transatlantic steamships are already equipped with the wireless telegraphy for communicating with each other and for sending messages ashore, but several of the installations have not as yet proved as successful as anticipated.

Before Sir Thomas Lipton sailed with his little fleet from Scotland to lift the *America's* cup, he had installed on his steam yacht *Erin* the De Forest system of wireless telegraphy. At the time of sailing there were no such stations on the other side, but several had been established along our coast, and it was for the purpose of communicating with land at this end of his voyage that this system was adopted. It will be remembered that when over a hundred miles from shore the operator at the De Forest station at Coney Island picked up, as it is termed, the *Erin*, and from that time on to her arrival in port was in constant communication with her. Since then the cup challenger *Shamrock III.*, her racing mate, *Shamrock I.*, and her consorts have made lower New York bay and the region behind Sandy Hook their mooring grounds, while by means of the wireless equipment Sir Thomas has at all times been in communication with the shore. Also, progress of the trial races between the two *Shamrocks* has been reported to the Associated Press by tis representative on board the *Erin*.



DE FOREST WIRELESS TELEGRAPH APPARATUS ON THE STEAM YACHT ERIN.

The Condenser is shown at the left hand with wires leading up to the mast, and the Responder or receiver is directly above the box at the right.



WIRING PLAN OF THE DE FOREST SYSTEM.

For the uninitiated to witness the transmission of a wireless message, it is indeed remarkable and hard to comprehend, yet to hear the receipt of a message is still more marvelous. In this system the messages are detected by an ordinary telephone receiver, and the waves emanating from the sending station, being caught and reproduced by the receiving wires and mechanism, are, as it were, heard faintly in the earpiece.

A special house was built on the *Erin* directly aft the mainmast, on top of the deck house, for receiving the

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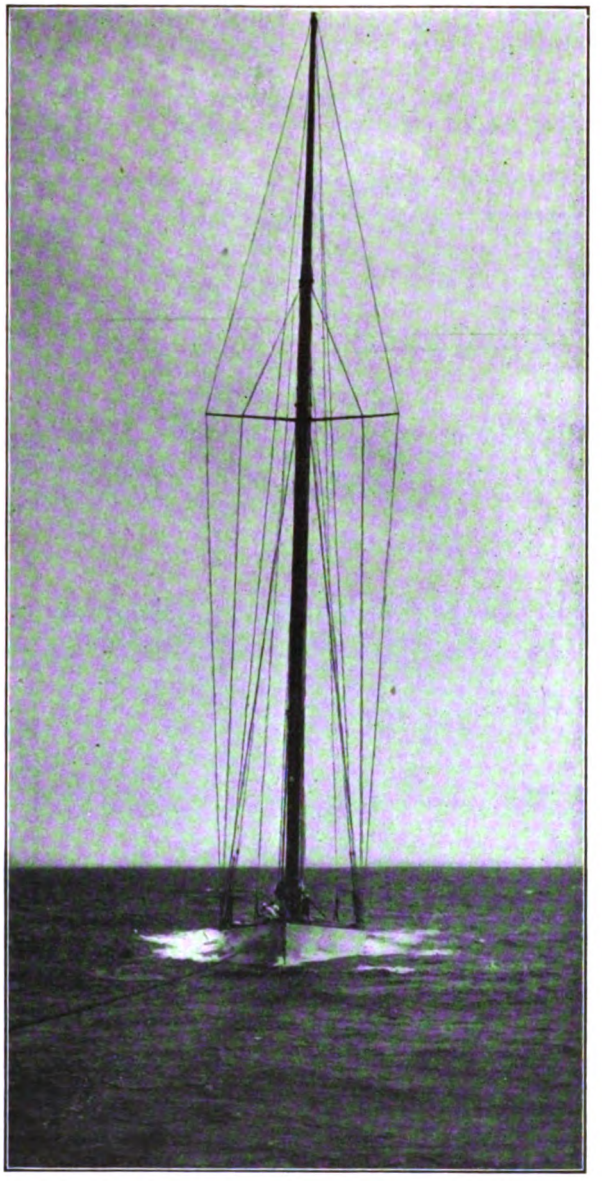
equipment, and through the roof extend the wires to the long antenna which is supported by a special gaff fitted at top of the mainmast.

The layout of this installation is shown in the diagram on page 446. A small motor-driven alternator supplies current at 500 volts. This passes through a choke transformer or lightning arrester, and thence to a step-up static transformer which raises it to about 20,000 volts tension. From here the wires lead through small spiral chokes to the condenser, which is made up of two sets of Leyden jars with a mushroom sparking gap and a variable induction coil. From one pole of the sparker connection is made to the antenna and the other leads to the ground. The return line from the antenna leads to the ground, and thus the transmitting circuit is completed.

For receiving messages, the receiver, which is connected as shown in the diagram, is thrown in by the switch. Here is the most fundamental difference between Marconi and all other systems of wireless telegraphy, in that no coherer is required. In its place is a little instrument called the responder, which serves the same purpose. The coherer, it will be remembered, consists of a tube filled with iron filings, through which the circuit from the antenna passes for the purpose of making and breaking said circuit at the quickest possible speed. The iron filings set themselves in line to transmit a wave, but when this ceases they are separated by tapping the tube. There are certain limitations to the speed of making and breaking the circuit through such an instrument, and it has been found that messages from a coherer cannot be sent much over a rate of ten words a minute. With the responder a speed of as high as sixty words per minute has been



SHAMROCK III. IN TOW.

[Photographed specially for Marine Engineering by E. Muller.]

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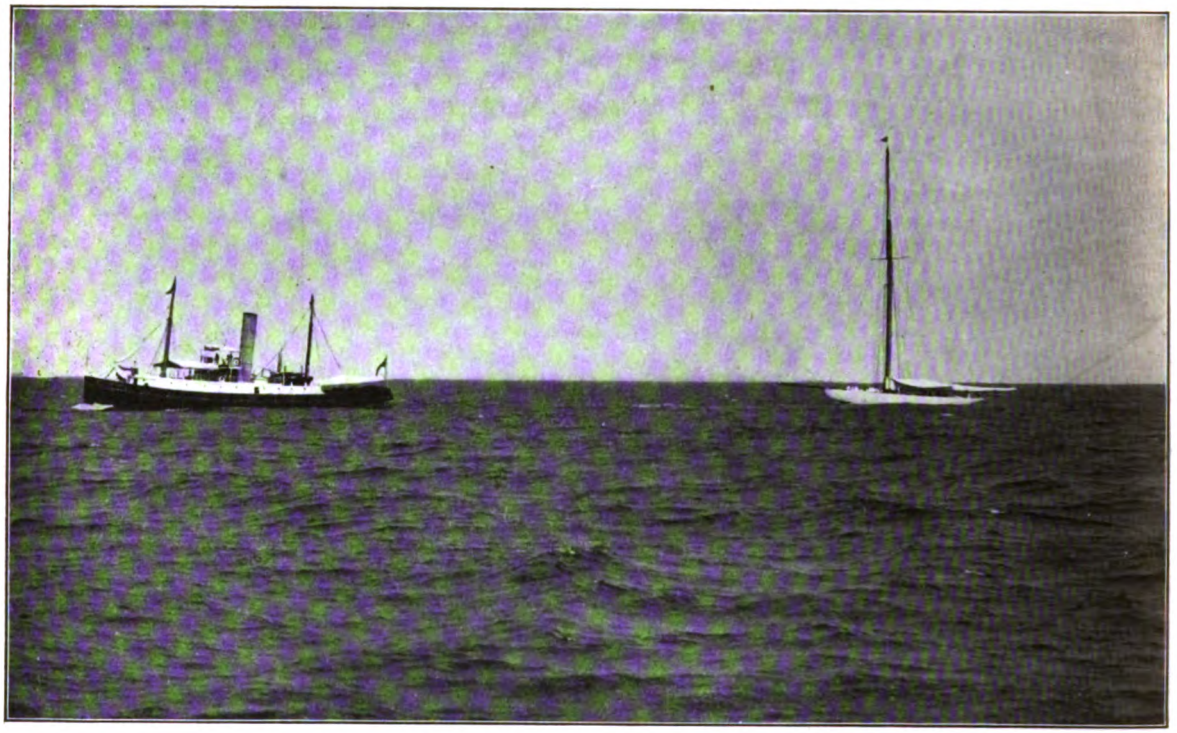
obtained. In fact, the only limit in the speed is the skill of the operator.

The responder is not an anti-coherer; for although the reaction of the electric waves upon it causes a sudden increase in its resistance similar to that observed with the coherer, yet this fact is due to entirely different action. At the present writing, owing to the fact that certain patents are pending covering this instrument, further particulars pertaining to the theory and operation are not yet available. The responder is not only extremely sensitive, but is instantly restored to its normal condition between each electrical impulse, and it is at once ready to transmit succeeding impulses resulting from the discharge of the spark at the sending station. If the telephone earpiece is not desirable for detecting the messages, a relay may be substituted for the telephone and the signals received on a Morse sounder. The telephone, however, seems to be preferred, and with it the receiving operator hears the dots and dashes emanating from the transmitting station. The responder works on a closed circuit and upon the current of an ordinary dry cell of several thousand ohms resistance.

A variable induction coil, shown in the plan connected to the condenser, is another very important feature of this apparatus. Up to this time it has been practically impossible to obtain a continuous stream of electromagnetic radiation adapted to this class of work. By varying the resistance of the induction coil, the number of electrical discharges across the spark gap may be obtained within any specified limits. In operation the dynamo charges the condenser, and when its potential reaches a certain point the discharge occurs across the spark gap, which sets up oscillations in the antenna wires. On account of the high resistance in the circuit, some time is required to recharge the condenser to the sparking potential. Hence the discharge is intermittent. In this device, by cutting off more or less resistance in the induction coil, any number of discharges may be secured. In other words, the apparatus can be tuned for practically any wave frequency. The mushroom type of discharge gap has been found best suited for this work.

Mr. De Forest has made use of the Lecher system for arrangement of the wires of his antenna. It consists of two parallel wires, connected at their ends to an apparatus producing electrical oscillations at high frequency, the wires being of the same length, and each one-quarter, or any multiple thereof, of the wave length of said electrical oscillation. Electromagnetic waves are then set up along the wires. If the corresponding nodes and loops of electrical oscillations in the two wires be connected together, the waves will not be interrupted; and, further, if these bridges be grounded, they lead off waves of different length than those to which the system is adjusted or attuned. The responder is placed at halfway between the nodes, or at a loop where all the energy of the system is electrostatic, and the instrument will receive oscillations of the greatest intensity.



SHAMROCK I. IN TOW OF TUGBOAT CRUIZER.

[Photographed specially for Marine Engineering by E. Muller.]

The inventor of this system, Mr. Lee De Forest, was graduated from Yale University in 1896. He made a specialty of the subject of the Herzian waves, taking a degree of Ph.D. for work along this line. The sending apparatus has been developed by Professor C. E. Freeman, E.E., of the Armour Institute of Technology. Also associated with Mr. De Forest in his work on the receiver was Mr. E. H. Smythe, of the Western Electrical Company. Basic claims for many important devices for transmitting and receiving apparatus, applied

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for by Mr. De Forest, have been allowed with remarkably little delay at the Patent Office.

Many instances are related by the owners of the De Forest system of picking up wireless messages of other systems, and, in some instances, of transmitting other messages from their own station before same were detected by the intended station. True it is that the speed with which the De Forest messages may be sent is of very great importance.

The equipment on board the *Erin* is of one kilowatt capacity. The motor generator is placed at the right hand of view on page 446, underneath the table, and is run by current supplied from the storage battery of the yacht's lighting plant. The alternating current from the generator is led to the choke transformer and then to the step-up transformer, where, as above stated, it is raised to a voltage of 20,000. From there one of the wires comes up through the table to the antenna and condenser. The condenser is shown at the left of the table, with the spark gap directly in front. The box on the right is the receiver. The operator's key is placed at the center of the table, in circuit between generator and transformer, and the message is sent according to the Morse alphabet. The switch shown is used for throwing in or out the receiver.

The system has worked most successfully on board the *Erin* and has been of great assistance to Sir Thomas Lipton. Messages are sent ashore on the hour and half-hour, and those from shore for the ship are sent out a quarter after and a quarter of the hour. This schedule has been adopted simply for convenience. One interesting feature, which is specially valuable to Sir Thomas in his trying-out races of the two *Shamrocks*, is that, with this system, the presence of electrical storms may be detected. In the trial races between the boats much care has, of course, to be exercised, when spreading new sails and trying the spars, not to wet or bulge the sails or part any of the standing rigging or spars. Sandy Hook is a favorite spot for thunderstorms and squalls, but the approach of the latter may always be foretold by this serviceable equipment.

The two *Shamrocks* have been in almost daily contest since the first of the summer, and the superiority of the new boat has been shown in every race. Sir Thomas Lipton has, as he states, come over here for the sole purpose of lifting the *America's* cup, and whether or not he will succeed is at this writing unknown; but sure it is that never has a foreign competitor held the esteem and affection of the American people to any such extent as has this gallant knight.

SHAMROCK III. COMING ALONGSIDE THE ERIN.

[Specially photographed for Marine Engineering by E. Muller.]

The *Erin*, designed by the famous Watson, is a yacht with most graceful lines. She is, in fact, in size and appointment almost a steamship. The quarters for owner, guests, and crew are all well arranged, and the former are most lavishly decorated and contain many interesting souvenirs of royal and other distinguished guests who have been the recipients of Sir Thomas' hospitality.

On pages 449 and 447 are given two most remarkable photographs of the *Shamrock III.*, one taken looking down on the challenger from the deck of the steam

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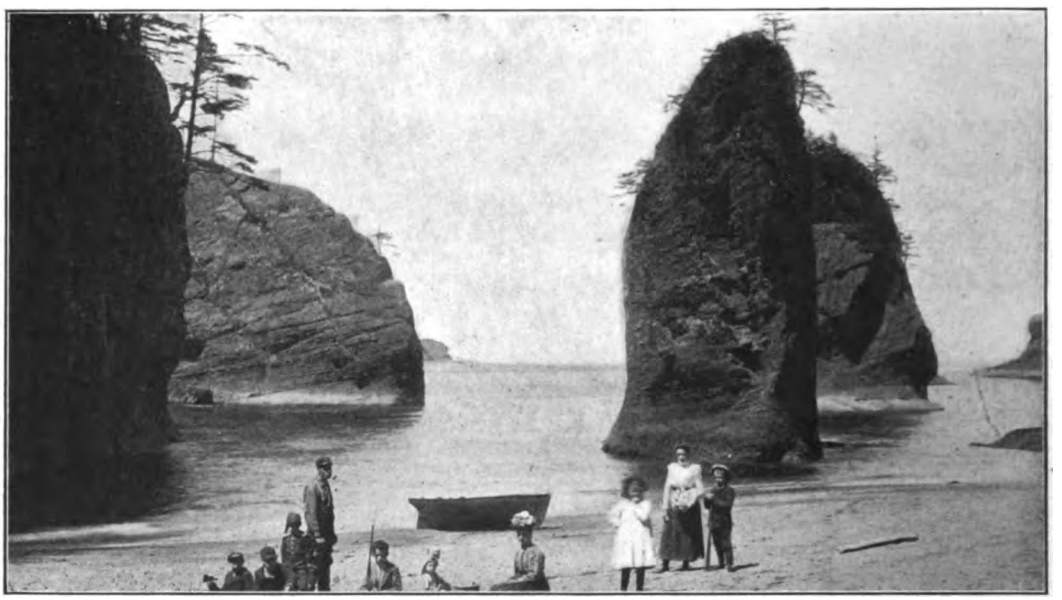
yacht, showing how graceful and fair is the form throughout, and the other taken of *Shamrock III.*, in tow of the Erin, being brought home from a trial spin. The extreme height of mast in proportion to the narrow beam is clearly brought out.

The fourth vessel of this fleet, the tugboat *Cruizer*, should not be overlooked. She is a typical seagoing tug of the English type and was the consort of the *Shamrock I.* on the transatlantic voyage, as the *Erin* was the consort of *Shamrock III.*

Many other installations of the De Forest wireless telegraph have been made on board ships. The scout boat *Unique* during the Army and Navy maneuvers was equipped with a 1 K. W. alternating-current generator driven by a Secor engine. Although the *Unique* was a small boat and the weather during the maneuvers was rough, the service rendered was such as to call for a commendation from the Chief Signal Officer.



CAPE FLATTERY, WASH., WHERE A THREE-TOWER DE FOREST STATION IS TO BE ESTABLISHED FOR TRANSMITTING WIRELESS MESSAGES DISTANCES UP TO 2,000 MILES.

The steamship *Coamo*, of the Porto Rico Line, was fitted with the De Forest system; and to show the facility with which the apparatus may be installed, it is stated that it took but two hours to put the instrument and antenna in place ready for service. Many other vessels on the coast and lakes are being equipped with this system.

Experiments have shown that the distance of transmission varies with the capacity of the machine. At present a large station is nearing completion at Cape Hatteras for the purpose of reporting the passage of vessels at this most important point upon our coast, and its capacity will be sufficient to transmit messages to the Coney Island or Block Island station, 360 and 460 miles distant respectively. Above will be found a view taken at Cape Flattery, Wash., where a station of 60 K. W. capacity is now being built. This, it is stated, is the first of a line of stations along the Pacific shores of America and Asia for sending messages to the far East.

Oceangoing Steel Tug John Scully.

A large oceangoing tug built by John H. Dialogue and Son, of Camden, N. J., for service in the Gulf of Mexico, has recently been purchased by Scully's Towing and Transportation Line, of New York, for sea towing between this harbor and New England ports.

The principal dimensions of the *John Scully* are as follows: length over all, 150 feet 6 inches; beam, 26 feet; depth, 17 feet 3 inches. The hull is strongly built of mild steel, with usual iron deck house and pilot house, the crew's quarters being in the forecastle. There are 7 water-tight bulkheads extending to the main deck; the forward collision bulkhead forming the fore peak tank, two forward of the boiler room forming deep tank or coal bunker, two between engine and boiler rooms, with passageway running through, forming the main coal bunker, and two aft of the engine room forming the after water tank. Besides the above-mentioned coal bunkers there are also wing bunkers alongside of boiler. The total capacity of the tanks is 60 tons, and coal bunkers have a capacity of about 300 tons.

The vessel is rigged in the usual manner for one of this class, with two pole masts. The equipment consists of two small boats, anchors, chains, galley stove, etc. The forward bitts are of cast iron, while the after bitts are of steel tubes stepped to a steel flat over the thrust bearing, which also supports the mainmast. There is also a steam windlass aft for hauling in hawser, and combined steam- and hand-steering gear of the Williamson pattern. As the boat was originally designed for hot climates, the two ventilators leading into the boiler room are extra large.

The vessel is driven by one set of vertical, inverted, direct-acting, triple-expansion, 3-cylinder engines, the cylinder diameters being 16 1-2, 24, and 41 inches with a common stroke of 30 inches. The cylinders are supported at the back by cast-iron columns forming the

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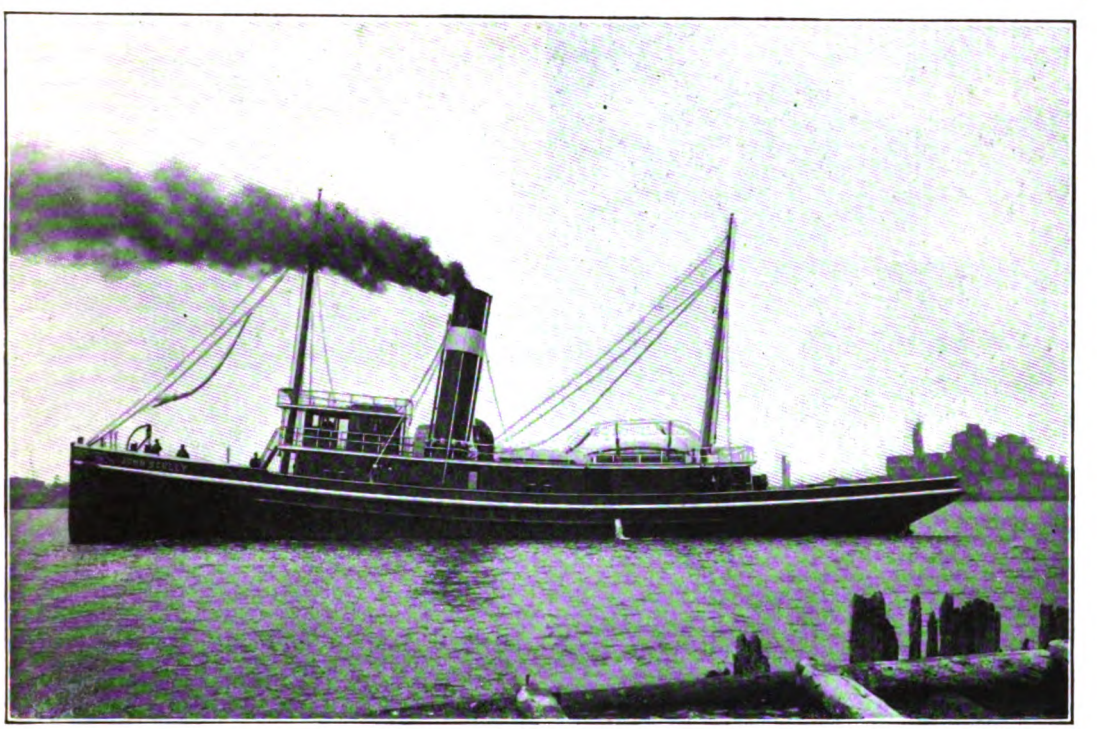
condenser, and on the front with wrought-iron columns. The guides are of the box pattern; the air, feed, and bilge pumps are worked from the main engine by levers from the intermediate crosshead; the circulating pump is independent and of the centrifugal type. The valves on the high- and intermediate-pressure cylinders are of the piston type, while the low-pressure has double-ported slide valves. The high-pressure valve has a removable liner and the low-pressure a removable face. All valves are on the forward side of cylinders and are operated by Stephenson double links. There is the usual steam reversing gear. The thrust shaft is made with collars fitted with horseshoe thrust bearings.

There is one single-end Scotch boiler, 14 feet 6 inches mean diameter and 11 feet 3 inches long. In this boiler there are three corrugated steel furnaces, 45 inches mean inside diameter and 236 3 1-2-inch tubes, including both stay and ordinary tubes. Each furnace has a separate combustion chamber and the working pressure is 175 pounds. In the recess in the after boiler-room bulkhead is placed a vertical cross-flue donkey boiler, about 3 feet diameter by 7 feet high, which can be run with salt water if necessary.

Among the auxiliaries there is a filter and independent feed heater, and in the upper engine room are placed the steam-steering engine and horizontal evaporator, and steam fan for ventilating the fire room; there is also a very large dynamo direct connected to horizontal engine. The steamer is lighted throughout by electricity, while on the pilot house is placed a powerful searchlight.

This boat has been chartered by the New York Yacht Club to lay out the courses for the international yacht races.



SEAGOING STEEL TUG JOHN SCULLY.

Modern German, English, and American Electric Launches.—II.

BY FRANK C. PERKINS.

The popularity of the electric launch is increasing in England, and numbers of them are to be found throughout the island; on the Thames river alone there is a fleet of over 40. Among the modern English electric launches should be mentioned *The Titan,* which is 45 feet in length and licensed to carry 40 passengers. It was built at Weybridge, Surrey, England, at the works of the Thames Valley Launch Company, Ltd. This boat has 54 cells of battery of the Leitner type, the capacity being 280 ampere hours with a discharge current of 40 amperes. The speed of this electric launch is about 7 miles per hour, and it is propelled by a Beevor-Edwards electric motor. It is built of teak, with handsome cabins well fitted throughout with plush and leather cushions.

Another handsome launch, built at the Riverside Works, is the *White Iris.* This electric boat is 30 feet long, and is driven at a speed of 8 miles an hour by means of the 5 H. P. electric motor.

The main works of the Thames Valley Launch Company, Ltd., as well as the principal charging station, are located at Weybridge, but there are other charging stations located at Maidenhead, Hurley, Henley, Pangbourne, and Shillingford.

It may be of interest to note the details of the W. Rowland-Edwards single-lever gear for electric launches, which is extensively used with success on the English electric boats. In the gear employed by the Thames Valley Launch Company, when one lever is switched on it gives the boat motion ahead or astern, at the same time varying the speed and stopping and

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steering when necessary. The following quotation from the *Marine Engineer* gives a good idea of the method of operation of this apparatus:

"Heretofore boats of this description have had their motors reversed, which wears the brushes by the sharp edges catching against the commutator and causing sparking. Separate mechanism has been necessary, too, for starting, stopping, reversing, and steering the boat, requiring, of course, proportionate extra attention in consequence. With the armature of the motor, however, always running the one way, the brushes are simplified and the operations named effected by a single lever or wheel. The system provides for a reversible-bladed propeller, the blades being fixed to a sleeve on the main shaft, and when the blades are at right angles

ENGLISH ELECTRIC LAUNCH CULLA RANEE.

to the shaft the propeller will simply revolve if the current is switched on, without doing useful work, and absorbing no current except that necessary to overcome the friction of the motor and shaft."

In the diagram, Fig. 1, a wheel, *a*, is placed in any convenient position in the boat for reversing. With it a bar, *b*, is insulated at its center, through which a spindle, *c*, passes and is fixed. This spindle is also connected to the wheel *a*, and at its lower end also to the rod or sleeve used for reversing the blades of the propeller. The bar *b*, insulated at its center, has upon each end conducting brushes *e*, *e*, and these brushes may slide over brass plates, *f*, which form segments of a circle electrically separated from each other, and only connected by means of the brush bar *b* when it is turned to the desired position by means of the wheel *a*. These segments are connected in the circuit by which the motor is actuated, and when the bar *b* connects them,

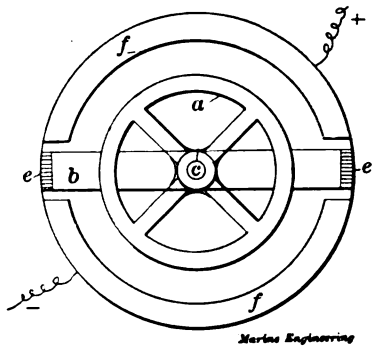

FIG. 1.

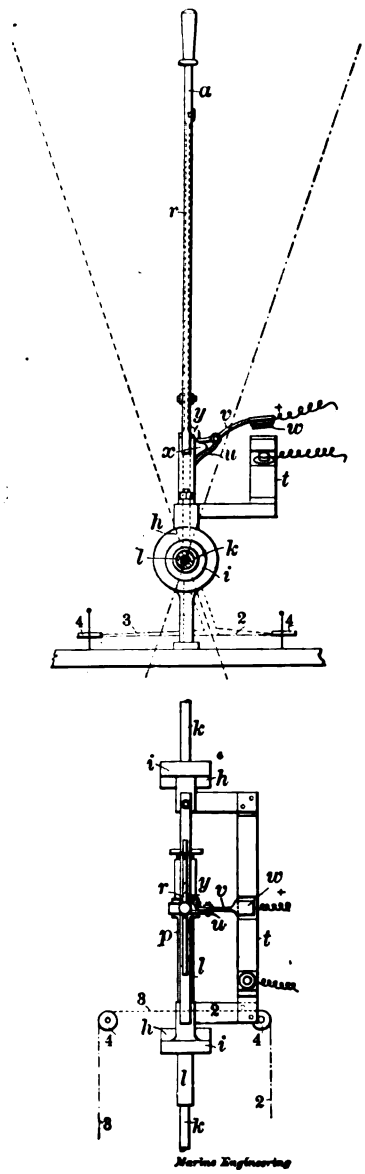

FIG. 2.

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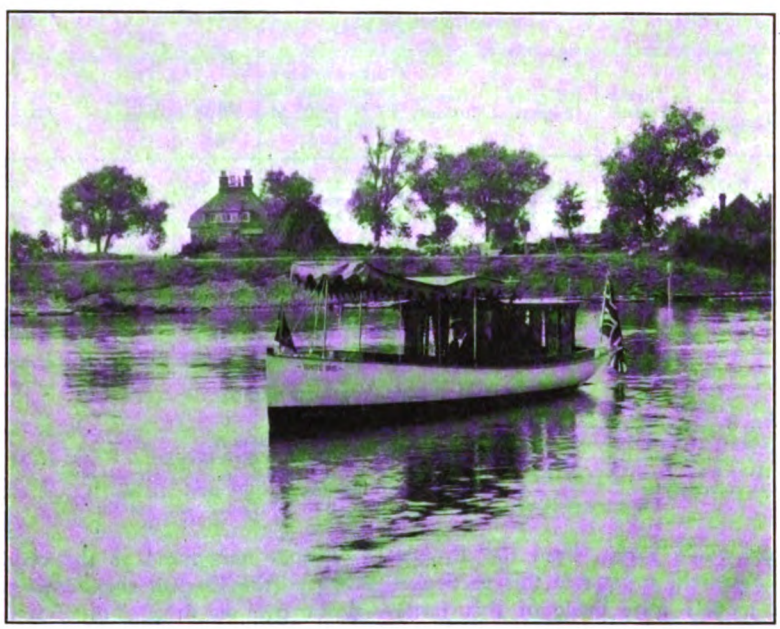
then the circuit is complete. If the wheel *a* is so placed that the blades of the propeller are at right angles to, or across the center line of, shaft—that is, in the neutral position—a gap or break is made in the brass segments *f*, so that the circuit is broken and no current passes. If the wheel *a* be turned slowly around in either direction, the blades of the propeller are also turned to the required angle with the shaft, and at the same time the brush bar *b* moves round and brings the brushes *e*, *e* into contact with the segments *f*, and so completes the circuit, and the boat commences to move forward or backward, according to the direction of the angle in which the propeller blades have been set, the motor itself always revolving in the one way. The current will be very slight at first, as there will be little resistance, and this will increase gradually as the blades are turned to a greater angle, and thus avoid a sudden rush of current, which is so detrimental to the motor and cells. The latter may be in series instead of two sets in parallel, the current given out being uniform. A single circuit only is necessary, and any speed is possible from dead slow to full speed.

The lever *a*, in Fig. 2, is represented attached to the steering gear of the boat, so that steering can be effected either with or without the starting, stopping, and reversing devices described, thus enabling the whole of the movements named to take place by means of this single lever only. To do this the lever *a* turns upon a center, *k*, upon the lower part of a frame, *h*, which itself swings in bearings, *i i*, carrying the propeller shaft. The quadrant *p* is a guide for the lever in the usual way, there being a spring catch, *r*, and notch for the central position of the lever, the movement of which gives the different positions of the blades for either ahead or astern driving. A supplementary parallel quadrant, *t*, is carried by the frame *h*, and has a curved metallic face connected with the electrical circuit. The lever *a* is connected with a bracket, *u*, in which is pivoted a lever, *v*, the outer end of which carries a brush, *w*, which is also in the electrical circuit, and a spring, *x*, tends to press the brush *w* against the metallic quadrant *t*. When, however, the lever *a* is in its central position, the catch *r* is forced into its notch, and a lateral projection, *y*, forces down the inner end of the lever *v* and breaks the contact between the brush *w* and the quadrant *t*. To a suitable part of the frame *h*, as at *i*, are attached ropes, 2, 3, which, after passing round pulleys 4, 4, are carried back to the tiller of the rudder, which they operate. As the motor is running always in one direction, it will not be injured if the lever is moved over from full speed ahead to full speed astern; and this is, of course, the most severe test to which the gear can be put. By this arrangement cells always work evenly and without rush of current, and, the motor always running one way, the annoying brush trouble is overcome.



ENGLISH ELECTRIC PATROL LAUNCH WHITE IRIS.

The *Culla Ranee* was constructed at the Riverside Works and is a high-class private electric launch, 35 feet in length. It is equipped with a Beevor-Edwards motor and a storage battery of 34 cells, with a capacity of 150 ampere hours when the current taken by the motor is 30 amperes. This boat is built in teak and mahogany with walnut fittings. The beams, panels, and seats are of walnut, and cabins of the same are located at each end. The boat is electrically lighted, and fitted with velvet carpets and cushions, and silk curtains, with sliding doors at either end, and all modern conveniences.

The 35-foot electric launch *Livonia II.* is equipped with the W. Rowland-Edwards single-lever gear described above, and will run 50 miles with ease on a single charge of the accumulators. The storage battery equipment consists of 48 Leitner cells, having a capacity of 200 ampere hours with a discharge current of 28 amperes. This current will propel at the full speed of 9 miles per hour by means of the Beevor-Edwards electric motor with which it is equipped.

(To be continued.)

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EXPERIMENTS ON THE RESISTANCE OF A SCREW STEAMER IN FREE ROUTE.—II.

BY H. ENNO VAN GELDER.

In Fig. 4 is shown a graphical representation of the data given in Table I. On the diagram is also shown a curve, *e, e,* according to Rankine's formula (Rules and Tables, p. 275). This curve does not agree with that which is furnished by the experimental results taken from the thrust block, but varies widely, in particular at low speeds.

It would appear that the formula must be in error, for in the case under consideration the difference between two curves, the one giving experimental results and the other theoretical, can hardly be due to an improper construction of the propeller. The high value of the efficiency, 70 per cent., shows furthermore that the propeller in question was very efficient in form.

With the purpose of investigating the question as to how large an error would result from the Froude analysis and model research, at least in this particular case, two paraffine models were made of this form, respectively one-seventh and one-fourteenth full size, and these models were then subjected to the usual trials for resistance in the Dutch government model tank at Amsterdam, under the direction of Herr A. von Beck, naval engineer in charge of this work. The results are given in Table II. and are shown graphically in Fig. 8. In this table will be found, in columns 2, 4, 6, 8, 9, the values from Table I., columns 3, 12, 5, 11, 8, respectively, repeated for greater convenience of comparison. Column 5 gives the net horse power which, according to reckoning simply from the model experiment, would be needed in order to propel the ship at the corresponding speeds. In columns 10 and 11 are shown the thrust power (column 4, Table II.) and the net power (column 5, Table II.), expressed in per cent. of the actual indicated horse power (column 2, Table II.). In column 12 may be seen clearly the degree of error involved in the well-known Admiralty displacement formula:

$$C = \frac{D^{\frac{2}{3}} V^3}{H}.$$

Froude first called attention to the fact, which was later proved by experiment, that at a given speed a ship propelled by its own propeller is subject to a greater resistance than if it were moved by a towline at the same speed. Froude named this difference "augmented resistance," which is here shown by the excess of the values of the thrust power in column 4 over those of the net or effective power given in column 5. In column 7 this excess is shown as a percentage of the corresponding value in column 5.

The graphical representations of these values, as shown in Fig. 5, give the following curves: Curve A shows the indicated horse power as given in column 2. Curve B shows the resistance of thrust power as given in column 4. Curve C shows the net or effective horse power as given in column 5, while curves D and E show respectively the values in columns 10 and 11. Curve E shows the fraction of the total indicated power which corresponds to that required to move the ship by a towline at the given speed.

TABLE II.

Number of Run.	I. H. P.		Thrust Power.	Effective Power.	Revolutions.	Increase due to augmentation, expressed as per cent. of col. 5.	Slip.	Speed, Knots.	Col. 4 / Col. 2	Col. 5 / Col. 2	$C = \frac{V^3 D^{\frac{2}{3}}}{H}$
	Developed.	Computed.									
1	31.03	26.38	19.76	15.80	94	25.06	1.55	6.97	63.68	50.9	183.3
2	50.56	45.24	33.16	27.42	111	20.90	3.47	8.07	65.58	54.2	174.5
3	80.24	74.36	53.22	42.74	127.5	24.50	6.04	9.02	66.32	53.3	153.6
4	132.35	128.67	89.43	70.69	148	26.50	9.60	10.07	67.57	53.4	129.6
5	170.83	176.37	118.85	87.75	160.5	35.40	13.40	10.47	69.57	51.4	112.8
6	230.58	246.44	161.40	108.46	175	48.80	17.37	10.84	70.00	47.0	92.8
7	260.32	278.91	180.29	120.22	180.5	49.90	19.04	11.01	69.25	46.2	81.1
1	2	3	4	5	6	7	8	9	10	11	12

DATA FOR SPECIAL THRUST BEARING.

Surface of collars	101 sq. in.	Moment	119.2
Maximum load	5,345 lbs.	Length of arm A	1 ft.
Coefficient of friction	.10	Pressure in direction BC	123.5 lbs.
Turning force	534.5	Load on slide	105 "
Moment arm	.223 ft.	Surface of slide	52 sq. in.

Load per unit area of slide ..... .31 lb.

Froude announced as the results of tests made in 1876 on the English ship *Greyhound* that in this particular case the value of this fraction, or the "propulsive coefficient," so-called, was found between 37 and 40 per cent., whereas Professor Flamm notes that under modern conditions the values will usually range from 40 to 54 per cent. According to the showing of curve E or column 11, it is seen that the values in the present case vary between 46.2 and 54.2 per cent., thus agreeing well with those considered applicable in modern practice.

If we consider with further care the various losses which Froude's analysis contemplates, it is plainly shown that these figures, which are empirical in their determination, call for some modification in the present case. Froude gives for the resistance:

(1) Due to the action of the propeller,

(2) Due to the friction of the propeller in the water,

(3) Due to the slip,

(4) Due to the friction of the engine,

(5) Due to the operation of the air, circulating, feed, and bilge pumps, respectively—the following values:

.4*EHP*, .1*EHP*, .1*EHP*, .286*IHP*, and .075*IHP*,

in which *EHP* denotes the effective horse power and *IHP* the indicated horse power as given in columns 5 and 2.

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Froude takes for the slip loss 10 per cent. and from these various figures there results E. H. P. ÷ I. H. P. = .287. As we have already noted, the trials of the *Vlaardingen* show that this value under modern conditions, while variable, is considerably greater than Froude's values. The loss due to propeller friction is quite empirical, and in default of more accurate data we may take the value as given. As regards the slip loss, we have in the present case definite values from which it is shown that it is variable and cannot be taken as constant under changing conditions. While the value of this loss cannot be determined *a priori* with accuracy, it must nevertheless be estimated in some manner. In the present case, however, the actual values can be determined from the data taken. The loss due to friction of the engine must still be arrived at by simple estimate. It had been intended to carry out certain experiments with an engine similar to that of the *Vlaardingen*, with a view of deriving some values of the friction loss, but this was ultimately found impracticable and the desired results in this particular were not therefore obtained.

Any one who has undertaken such experiments will realize that it is exceedingly difficult, if not impossible, to obtain good friction diagrams unless the engine is provided with flywheel of adequate capacity. From such diagrams taken from stationary engines from time to time, however, it has been shown that the frictional loss in modern practice will usually be found about 12 per cent., and, based on such diagrams, this value may be adopted for the purpose of the present analysis, as sufficiently close for all practical requirements.

The work required to operate the pumps noted under (5) can usually be determined, if necessary, by direct measurement of revolutions and pressure from diagrams.

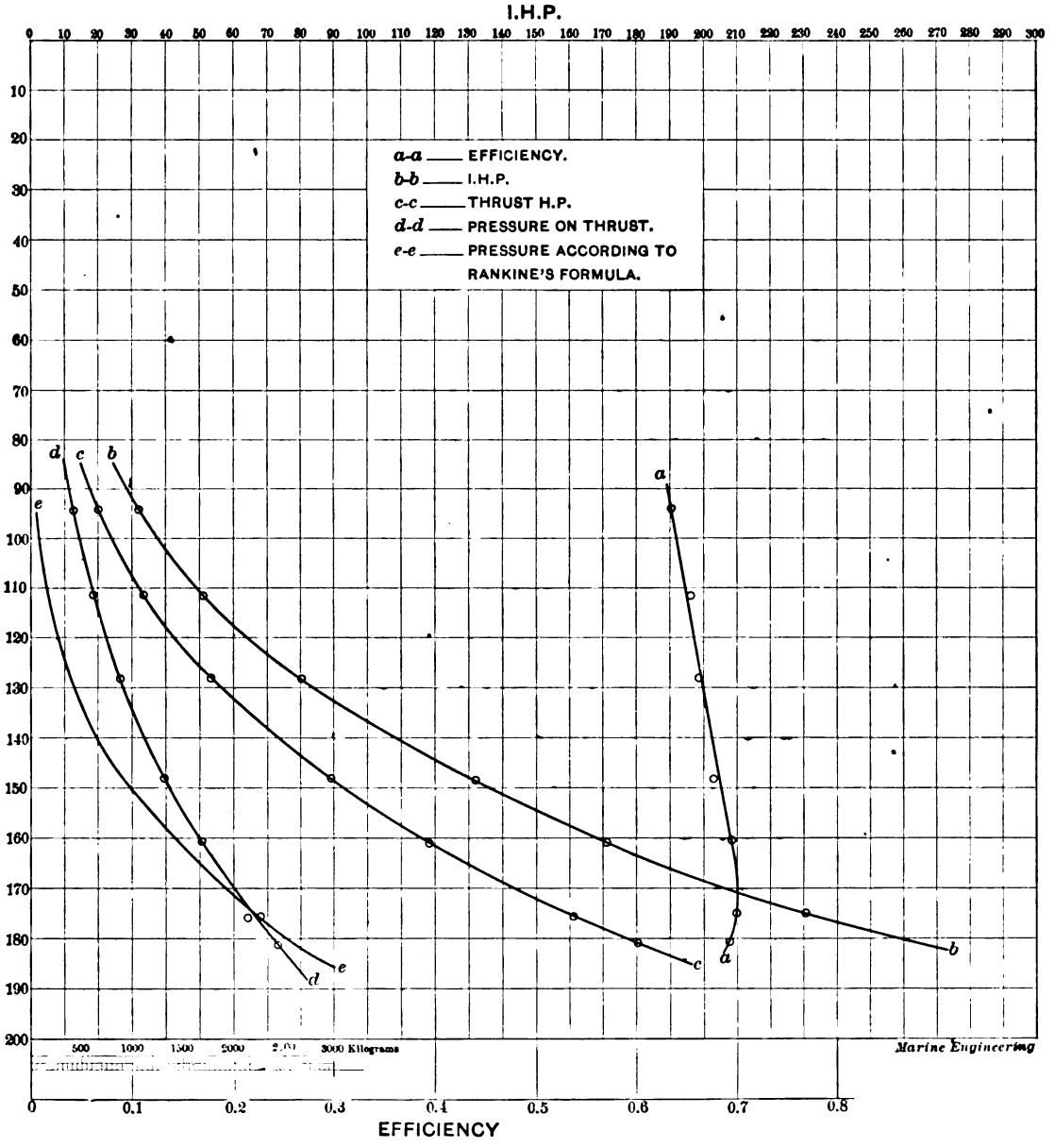

FIG. 4.

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In the case of the *Vlaardingen* this was found to be about 6 per cent. of the I. H. P.

If now the various components of the work be computed after the manner of Froude's analysis, but with the corrected values given above, there result the figures in column 3, Table II., and which are also shown graphically by the curve F, Fig. 5.

While it is possible to thus include the work required to operate the pumps, it is nevertheless better not to express the latter as a per cent. of the I. H. P., but rather to eliminate this item from the account, or rather to separately compute this part of the resistance work, having reference to the revolutions. Such an investigation gives the curve B, Fig. 6, which is seen to agree quite accurately with curve A, Fig. 6, the latter being the same as curve A, Fig. 5—that is, the curve of total I. H. P.

In connection with the investigation, the wave line developed at the speed of 11 knots was noted. As this run was made at a later time, the draft was no longer the same as for the earlier runs, the values for the wave line run being 1.24 forward and 2.25 aft.

At equal distances on the deck were stationed men with laths, by means of which during the run the distance at each station was measured from the rail to the surface of the water. From these indications the wave contour as shown in Fig. 1 was constructed. The form of the wave at this speed is quite favorable, since it results in a considerable increase in the depth of immersion of the propeller and doubtless aids in the efficiency of its propulsive action. This wave contour agrees quite closely with that which was shown by the model at the corresponding speed.

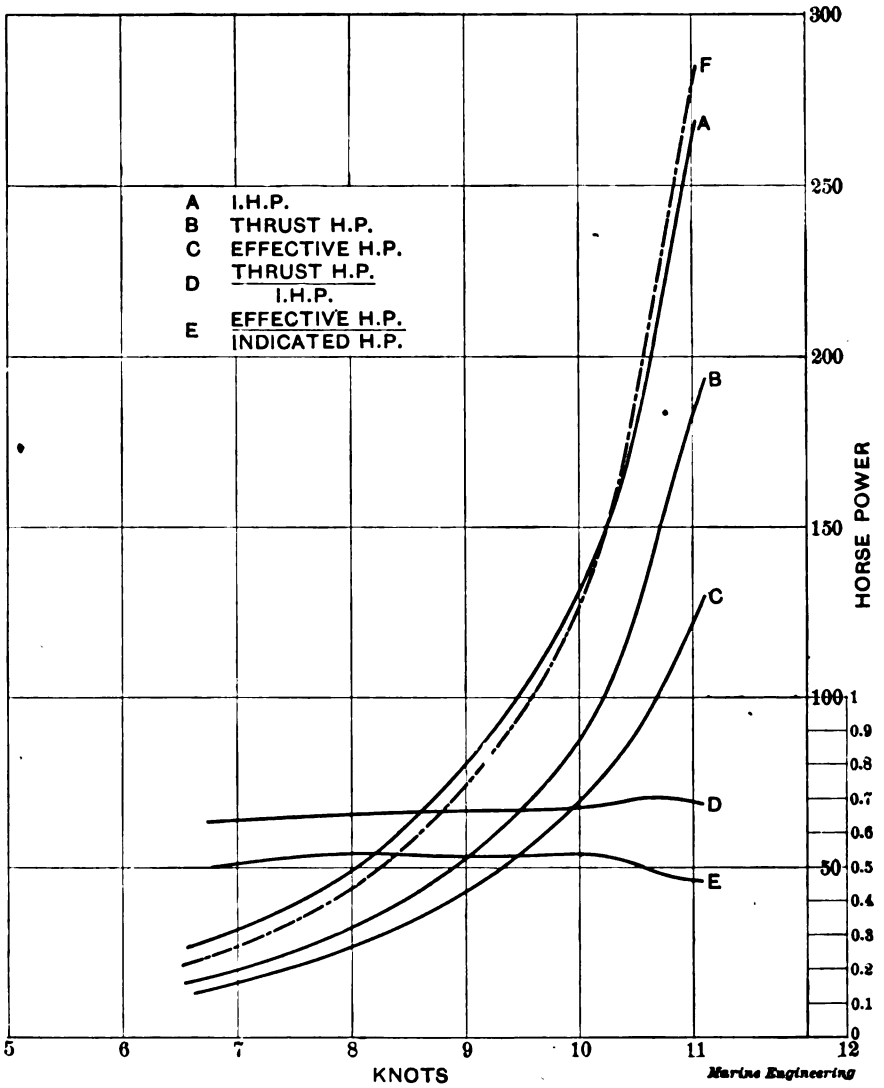

FIG. 5.

Aft of the propeller, however, the ship wave is somewhat higher than the model wave, a result naturally arising from the operation of the propeller.

The more important results of this research may be summarized as follows:

(1) That the satisfactory determination of the percentage values of the constituents of the I. H. P. calls

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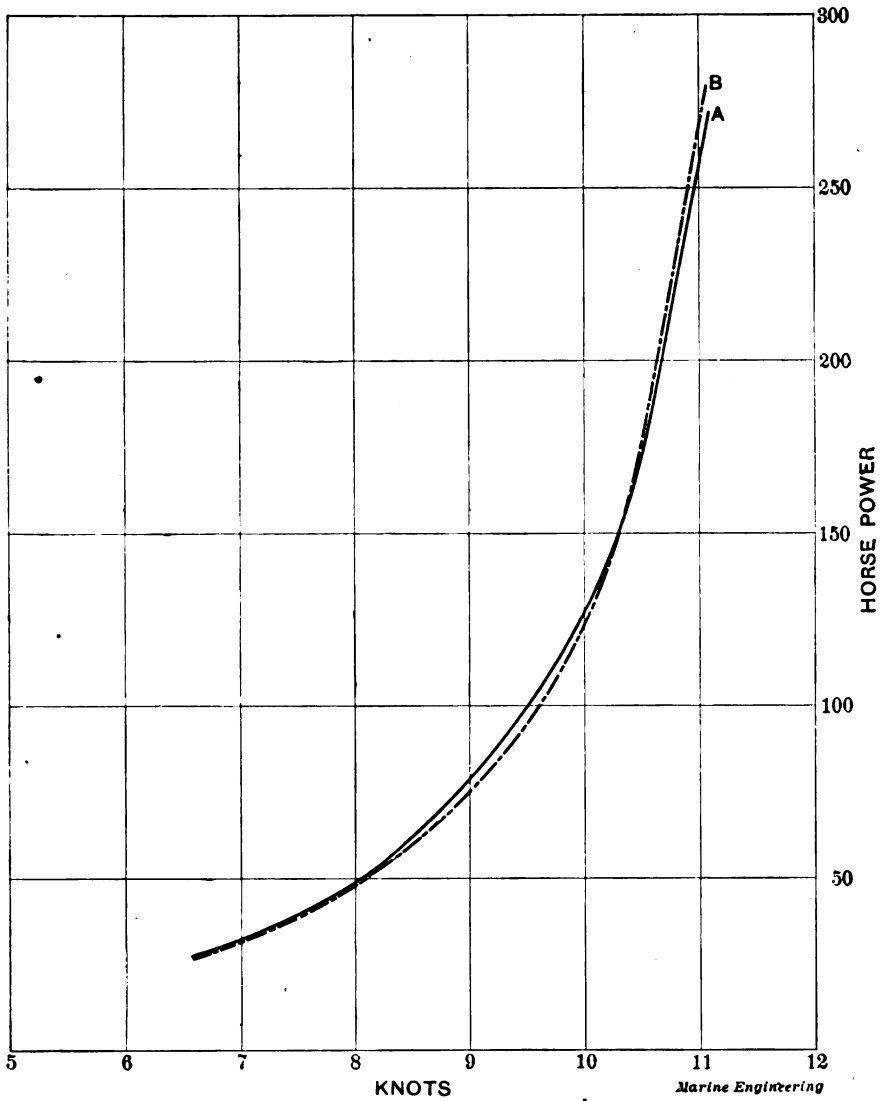

FIG. 6.

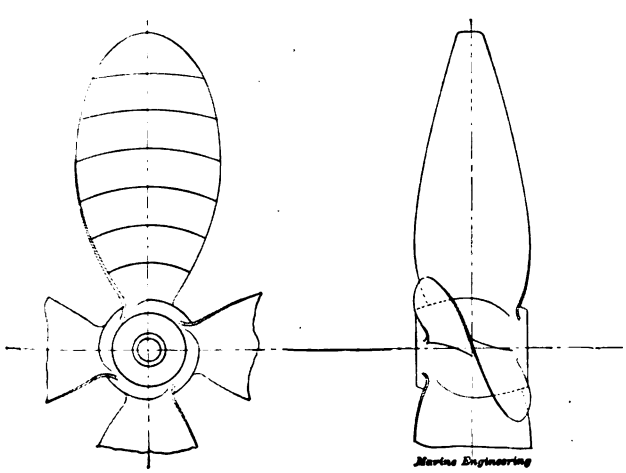

FIG. 7.

for continued experimental research on full-sized ships, and of well-selected types covering the field of marine design.

(2) That in my opinion there exists no technical reason why such experiments should not be carried out even with ships of still greater size.

It may furthermore be hoped that both builders and owners, whose common interest demands a clearer understanding of these matters, may unite to this end and allow no considerations of expense or loss of time to prevent the carrying out of such a series of experiments. In my opinion the government naval authorities may also aid in such a research through the provision of both material and labor, and by giving freely, for general benefit, the results thereby obtained.

Monthly Shipbuilding Returns.—The Bureau of Navigation of the Department of Commerce and Labor reports 117 vessels of 25,460 gross tons built in the United States and officially numbered during the month of July, 1903.

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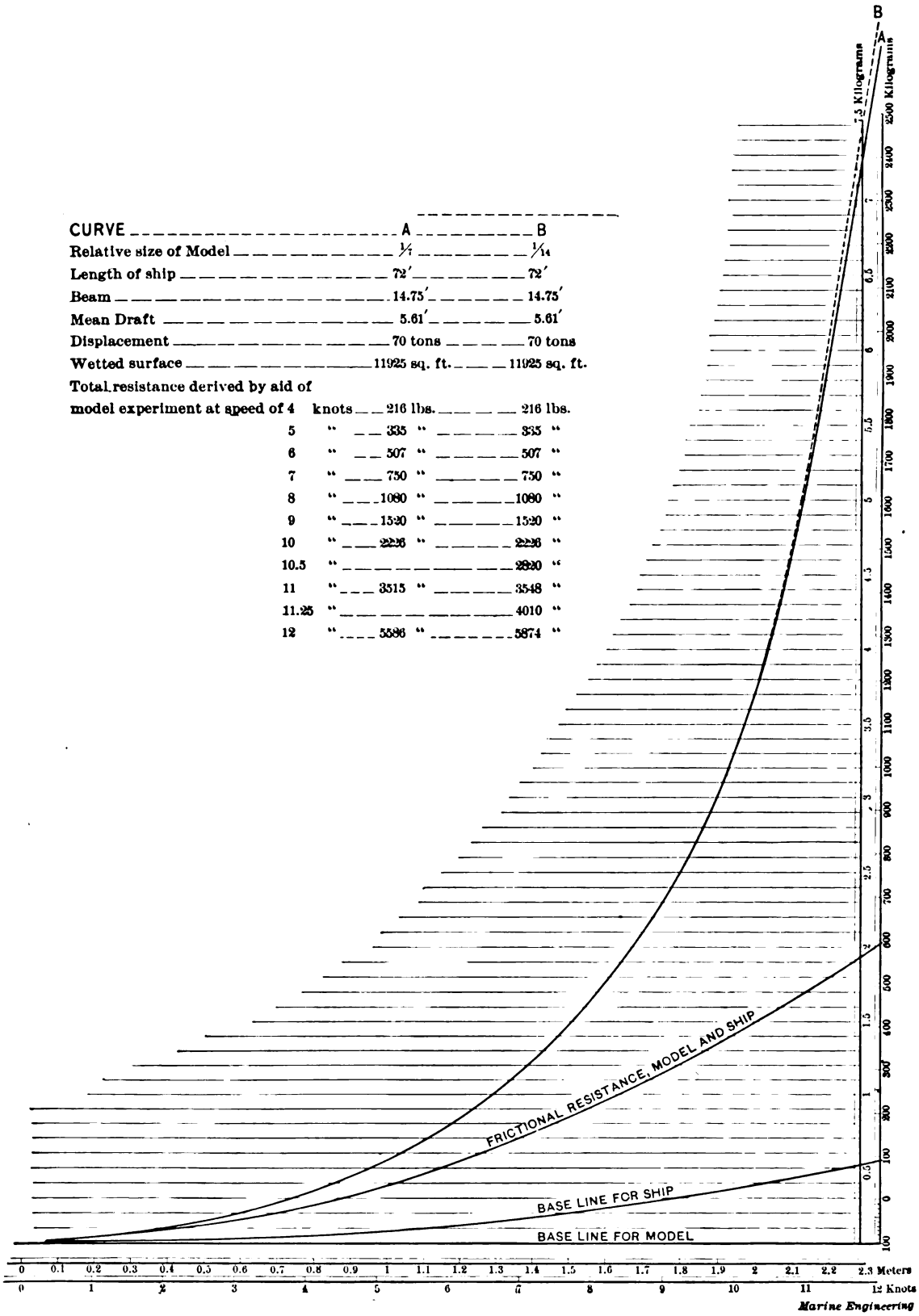

FIG. 8.

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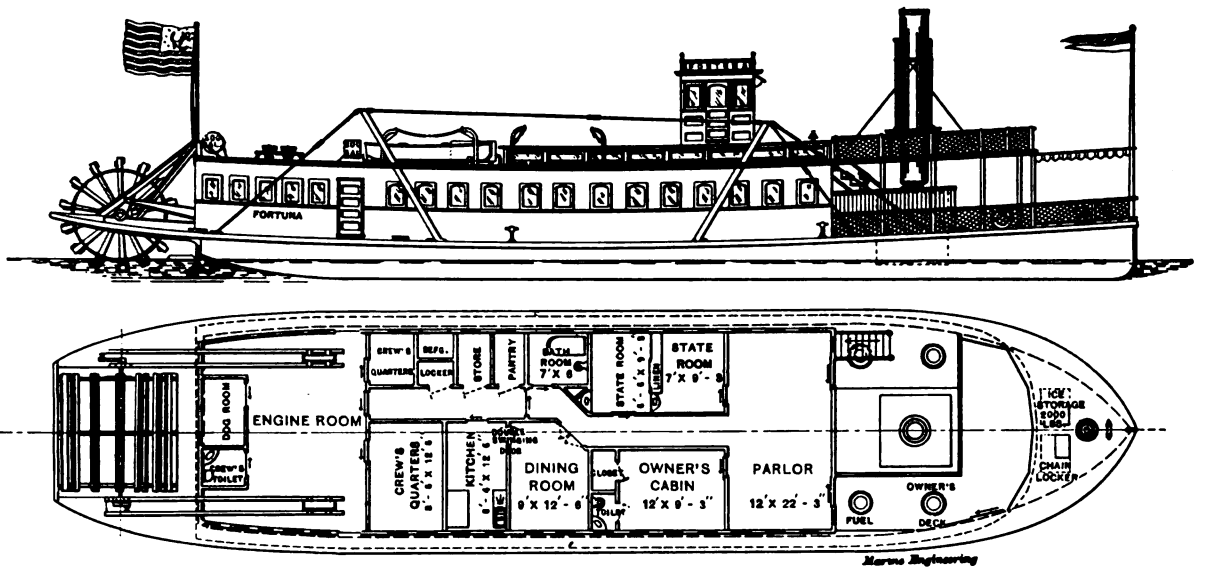
STERN-WHEEL STEAM YACHT FORTUNA.

The houseboat as a means of enjoying a comfortable summer outing was briefly described in the August number of MARINE ENGINEERING, and in the present article, which deals with the steam yacht *Fortuna*, will be found a description of a boat which, though termed a yacht, and is such in the Western sense of the word, yet to all intents and purposes, to a salt-water sailor, embodies the advantages of the houseboat and, at the same time, permits of navigating shallow streams and at a good speed.

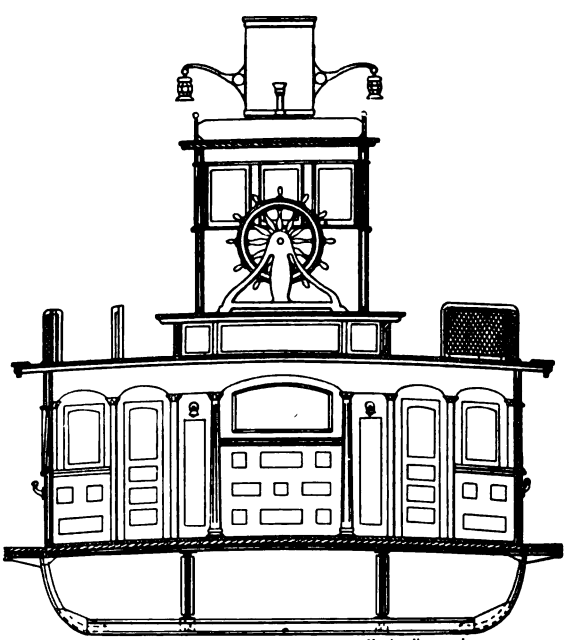


DECK PLAN AND ELEVATION OF A SPORTSMAN'S YACHT FOR SERVICE ON WESTERN RIVERS.

The *Fortuna* was built for a hunting boat by the Marine Iron Works, Chicago, Ill., for Mr. John W. Parmelee, Chicago. During the summer months the owner has cruised in Northern rivers and lakes, while in the winter the *Fortuna* will be taken to points where good fishing and hunting abound along the shores of Southern streams and the Gulf of Mexico.

Briefly described, the *Fortuna* is a stern-wheel boat 119 feet 9 inches from stem to after end of the paddle-wheel frame. Two simple engines are placed in the stern and a water-tube boiler is located forward. The hull is built of steel and subdivided into 7 water-tight compartments by 6 thwartship bulkheads. The deck house extends for a length of 70 feet amidships, and of this length 42 feet is devoted to the owner's quarters and accommodations for the crew. This type of boat is particularly desirable for a yacht, in that the choicest part of the craft, that amidships, is given over to the owner, while the engines and boilers are at the ends. In the steam yacht, as with other steam vessels of the ordinary type, this arrangement, as is well known, is reversed, and the owner must content himself with cabins at the ends of the vessel or in the deck house above.

Referring to the plan on this page, it is seen that at the forward end of the yacht is a large parlor extending from side to side of the vessel. This large and airy room is finished in bird's-eye maple and is well shown in the illustration on page 462. The owner's state room on the port side, and one of the two large guest rooms placed on the starboard side, are finished in mahogany, and the hallway, dining room, and second state room are finished in oak. A passageway 42 inches wide leads aft of the engine room. On the starboard side is the dining room, entered by double doors from the passage,



MIDSHIP SECTION OF THE FORTUNA.

and aft of it is the galley, which is wainscoted and has a tiled floor; on the port side a bath room, finished in bird's-eye maple with vitreous tiling and wainscoting, adjoins the state room. Passing through a sliding door, the rest of the passage is found to be devoted to pantry,

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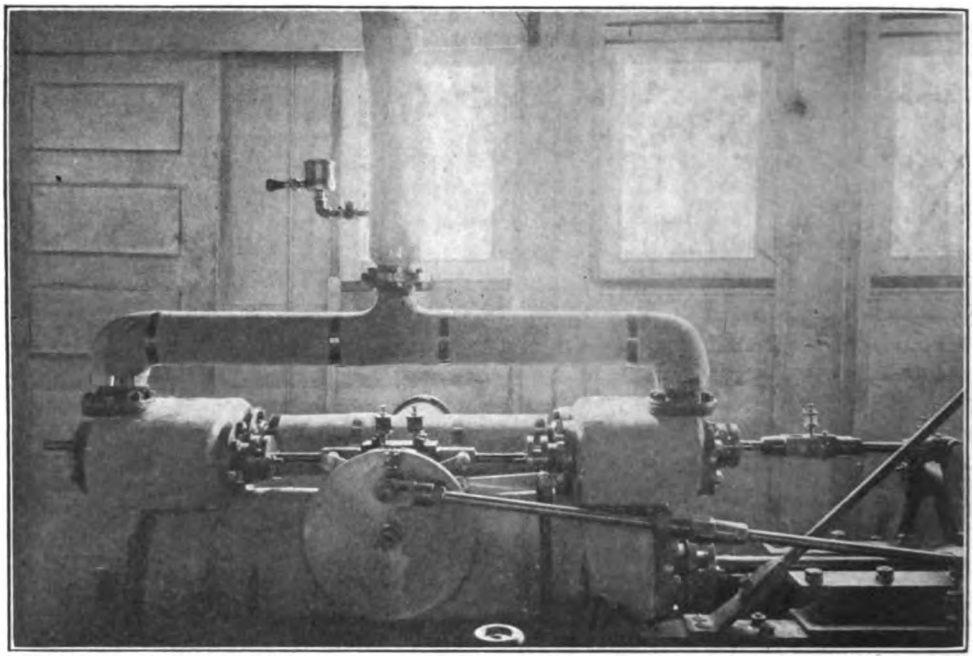

VALVE GEAR ON HIGH-PRESSURE ENGINE OF THE FORTUNA.

stores, crew's quarters, etc. The engine consists of two simple, direct-acting, horizontal engines, 9 inches diameter and 42 inches stroke, fitted with special patent cut-off valves operated by a wrist plate, as shown in the view above.

For a hunting boat to be complete there must be a place for the dogs; by referring to the plan it will be seen that there is a "dog room" at the after end of engine room.

The engines work on either end of the main shaft, which is 4 3-4 inches diameter and hexagonal section. The wheel is 13 feet diameter, fitted with 14 double buckets 12 feet 9 inches long. Each bucket is 8 1-2 inches wide, and those on the forward side of spokes overlap those on the after side by 1 1-2 inches, so that the total width of the face is 15 1-2 inches. With full pressure of steam, namely, 225 pounds, the engines will make 25 revolutions, developing 134 I. H. P., and will drive the vessel at a speed of 11 1-2 statute miles per hour.

The feed pump is a Worthington duplex outside-packed plunger 5 1-4 by 3 1-2 by 5 inches; there are two feed-water tanks, 1,000 gallons capacity each, and one Worthington duplex 3 by 2 by 3-inch tank pump for filling these tanks. One tank of 192 gallons capacity is used for sanitary purposes, and two tanks, each of this same capacity, are used for carrying drinking water. A 4 by 4-inch engine drives the electric-light dynamo by a noiseless chain at 600 revolutions. There are sixty 16-candle-power lamps fitted on board, also one 1,000-candle-power searchlight on top of pilot house. The water-tube boiler mentioned is placed forward on a level slightly below the water line, and coal is stowed in the hold through four coaling scuttles, two on either side. The normal supply of coal is 14 tons, while 17

NAME—Fortuna. **NATIONALITY**—American. **TYPE**—Western river yacht.

LAUNCHED—1903. **BUILDER**—Marine Iron Works. **OWNER**—John W. Parmelee

Length over all	119 ft. 9 ins.
" of hull	103 "
Beam, molded	23 "
" over guards	26 " 6 "
Depth, molded	4 "
Draft, load	3 "
Displacement	107 1-2 tons
Gross tonnage	150
Engines:	
Type	double high-pressure
Cylinder diameters	9 ins.
Stroke	42 "
Valves	piston, patent adjustable cut-off
Length of pitman	14 ft.
Wheel:	
Diameter of shaft	4 3-4 ins. hex.
" wheel	13 ft.
Number of buckets	14
Length "	12 ft. 9 ins.
Width of each bucket	8 1-2 "
Buckets overlap, actual total width of face	15 1-2 "
Revolutions	25
I. H. P.	134
Speed	11.5 miles
Boilers: Number	1
Type	water-tube
Width	8 ft.
Length	8 "
One furnace.	
H. S.	1,066 sq. ft.
G. S.	41.6 " "
Steam pressure, 250 lbs. allowed; 225 lbs. average carried.	

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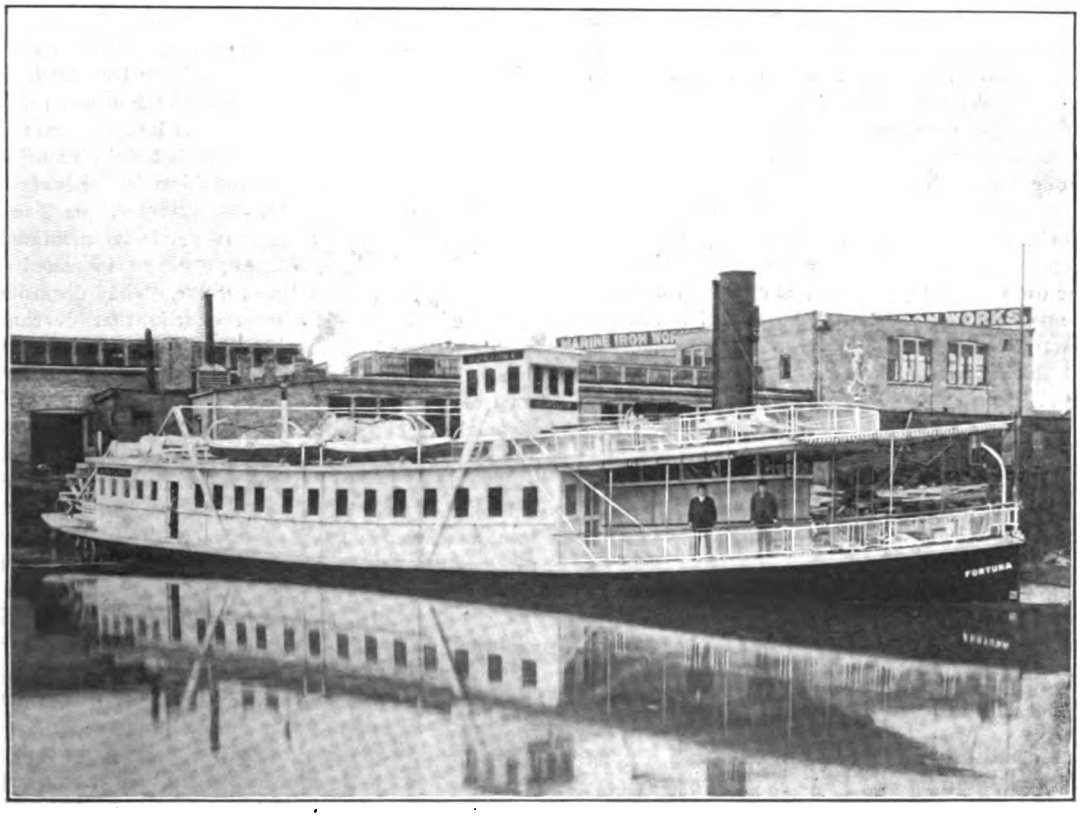

BOW AND STERN VIEWS OF THE FORTUNA AT THE DOCKS OF THE BUILDERS, THE MARINE IRON WORKS, CHICAGO, ILL.

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MAIN CABIN ON THE FORTUNA.

tons may be carried. The boiler is 8 feet square and has a grate 6 feet 8 inches square, thus giving a grate surface of 41.6 square feet; the total heating surface is 1,060 square feet. There are two feet of deck around the main house over the guards, with hand railing placed at the inside. The deck forward is built of Douglas fir, and is fitted up for the owner, while at the bow are two hatches, one for a chain locker and the other for ice storage for 2,000 pounds. Here are also placed the anchor davit, bits, and capstan. A stairway at the side leads to upper deck, the forward end of which is railed off for the owner. The pilot house is on top of dome.

This convenient and unique type of vessel is but another illustration of the ingenuity of the designer to carry out the requirements of an owner for a special type of boat.

Webb's Academy and Home for Shipbuilding.—The ninth annual report of Webb's Academy and Home for Shipbuilders has been issued, presenting a prosperous condition of the Academy, both financial and in its educational work. The institution was completed in May, 1894, and presented by Mr. William Henry Webb to the trustees together with an endowment for its maintenance in perpetuity. As is well known, this institution affords free relief and support to aged men who have been engaged in building ships in this country, and also furnishes young Americans a gratuitous education in the art and science of shipbuilding and marine engineering. This year's graduating class numbered sixteen. A register of the graduates of the classes since 1897 shows that with hardly an exception, they have all followed the profession studied at the academy and have met with exceptional success.

STEAM TURBINES.*

BY PROFESSOR RATEAU, PARIS.

As is generally known, it is to the Hon. C. A. Parsons principally, and to the Swedish engineer De Laval, that is owing the general introduction of the steam turbine into practical engineering during the last ten years. It should, however, not be forgotten that the idea of this type of motor had already taken form in the brains of several inventors, and that, among them, the French engineer Tournaire is entitled to particular mention as having in 1853, just half a century ago, indicated the capabilities of the steam turbine. The disposition Tournaire indicated is almost exactly that developed thirty-two years later by Mr. Parsons, with, it is true, some very ingenious improvements which have assured the success of the engine. Tournaire also conceived the helicoidal gearing since adopted in the De Laval system.

As in the case of reciprocating steam engines, steam turbines are heat engines, converting the calorific energy of the steam into directly-available mechanical energy. From another point of view they are analogous to hydraulic turbines, and form part of the general class which the author will call "turbo-machines." To a person well grounded in the thermodynamic properties of steam, and possessed also of a thorough knowledge of the theory of the hydraulic turbine, nothing is easier than to design with confidence a steam turbine to satisfy a given purpose, provided, it should be understood, that he has previously determined the working coefficients to introduce into his calculations. Piston engines are not susceptible of such exact calculations, owing to losses at the admission and exhaust ports, and also to

*Paper read at the Engineering Conference of the Institution of Civil Engineers, Section V. *Shipbuilding*, June 19, 1903.

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cylinder condensation. In turbines the expansion of the elastic fluid can be pushed to its extreme limit much more conveniently than in the case of piston engines, whence they share the advantage of employing condensers giving the best possible vacuum. On the other hand, friction and leakage increase in proportion as the pressure is raised. From these opposite conditions it results that, for low pressures, turbines are more advantageous than reciprocating engines, while they generally consume more than the latter when the pressure of the exhaust is that of the atmosphere, or higher.

As in the case of their hydraulic analogues, steam turbines may be divided into two principal classes—action and reaction turbines; and each of these classes is subdivided accordingly as the turbine is composed of a single wheel or of several wheels, traversed successively by the steam in course of expansion. Among reaction turbines (analogous in hydraulics to the well-known Jonval turbine), of which, as multiple machines, the prototype is the Parsons turbine, the steam is only partially expanded in the distribution, and acquires its full expansion in the movable wheel. The steam therefore acts on the blades at once by its pressure and its velocity. The movable wheel is thus subjected on its two faces to pressures of different amounts, causing longitudinal thrust, which has to be balanced. These differences of pressure render it necessary to reduce to a minimum the clearance between the movable wheel and the wall by which the steam tends to escape without traversing the blades and so doing useful work. It is indispensable that the distribution of the steam should be effected over the whole circumference of the movable wheel, in order to avoid movements of pulsation very prejudicial to efficiency.

In the "action" turbine, on the other hand, the steam only acts on the movable wheels by its velocity. Each wheel revolves in a casing in which the pressure is uniform. Therefore the steam does not produce any sensible longitudinal thrust on the moving parts, which dispenses with the necessity for any special provision to neutralize such thrust. The steam does not tend to rush across the blades in order to pass from one face to the other at the expense of efficiency. It is therefore possible to provide sensible clearance between the moving and fixed parts, and consequently to disregard the wear of the shaft bearing. Further, it is possible, if need be, to project the steam on to one point only of the circumference. Finally, under the same conditions, "action" turbines revolve at a less velocity than "reaction" turbines. This renders more easy the direct coupling to the machines worked.

The prototype of the simple-action turbine is that of De Laval. The author conceives that the multiple-action turbine offers greater advantages. It is therefore a motor of this type that he has developed latterly. His turbine, known as the "multicellular," is composed of sheet-iron wheels in greater or less number, fixed on the same shaft, and separated one from another by flat diaphragms. Many of these machines are already at work. Wheels of single sheet iron suffice up to a diameter of about 1 meter (39 inches); above this diameter it has been found advisable, in order to avoid deformation, to make the wheels of two conical disks of that metal. These multicellular "action" turbines can be disposed so as to run with very little loss from friction or from leakage, and, as a result, the consumption of steam is proportionately small at any load.

It is not necessary to insist on the well-known advantage possessed by turbines in general of their smooth and continuous movement of rotation; but the excessive speed for which they are obliged to be designed, in order to meet the speed of flow of the steam, constitutes in many cases a serious inconvenience—*e.g.*, in its application to ship propulsion. For a long time this hampered their use for electric installation, but latterly dynamos of very high speed have been constructed, worked by steam turbines, constituting an outfit of light weight, requiring small space, and, although of ample power, of low cost, and, as a consequence of working and upkeep, as simple as can be desired. It follows that for this purpose the steam turbine may be expected rapidly to supplant the piston engine.

Direct-coupled to ventilators and centrifugal pumps, steam turbines, owing to their capability of producing great power at high speed, exhibit surprising results. The author has installed turbo-ventilators giving a pressure of half an atmosphere, and turbo-pumps with a lift of several hundred meters. He is prepared to instal plants of several thousand horse power compressing air to more than 6 atmospheres, or raising water to more than 600 meters (say 2,000 feet). This shows that the steam turbine possesses vast possibilities.

DISCUSSION.

In London *Engineering* the following discussion on Professor Rateau's turbine will be found, and is condensed as follows:

The discussion was opened by Mr. Jude, who stated that more data were wanted before the condensing reciprocating engine could be discarded. A good deal was said about working with turbines with low vacua, but he would like to know what was the extra cost. Marine engineers reckoned that 26 inches was very good, but the turbine people all spoke of 28 inches. What had to be paid for this extra 2 inches? The author had made reference to working coefficients, but it would be necessary to know what was their nature before an opinion could be formed; these things were known of the ordinary engine, but the turbine opened up a new field. Some time ago M. Rateau had made experiments, which had been published, on the flow of steam through orifices; but these orifices were of a regular nature and very different from the passages through the turbine. It might be that if the coefficients were taken from these experiments and applied to the working of the turbine, the deductions formed from such theoretical tests might be found illusory. The author said that in the multicellular turbine there was no fall in pressure in the cell. He asked if this statement was founded on observation. Had the author ever taken measurements to prove the fact? It was maintained that there could be no fall in pressure, as there was no thrust. Certainly the thrust must be small, as there was no thrust block; but it was desirable to know what were the absolute facts of the case.

Mr. H. F. Fullagar, who was the next speaker, admitted that, as Professor Rateau had said, given the necessary constants, it was a perfectly straightforward problem to design a turbine of a given power to run at a

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given speed, and to foretell with scientific accuracy the steam consumption. But he would draw attention to the reason which made the problem increasingly easy as the power was increased, so that the building of large turbines was a matter of the greatest certainty. The feature which really distinguished the De Laval from other turbines was that, as the whole expansion of the steam took place in a jet, leakage was avoided. On the other hand, as the jet was necessarily inclined to the plane of the wheel, the axial component of the velocity—usually one-third (equal to one-ninth of the energy of the steam)—was lost, and, what was in practice more serious, the turbine was suited for full speed only, a reduction in speed being followed by a wholly disproportionate reduction in efficiency. The Curtis turbine shared to some extent both these disadvantages, but especially the latter, and was apparently unsuited to marine purposes. Large turbines then would, for the most part, be of the multiple type, in which there was a gradual fall of pressure from end to end; and the problem of leakage then presented itself, whatever the particular design might be. In M. Rateau's turbine, for instance, there was certainly no difference of pressure in the chambers themselves, and therefore no tendency to leakage around the wheels; in fact, M. Rateau was able to make wheels, up to a yard or so in diameter, of sheet steel about 1-8 inch thick only, which would be incapable of resisting even a slight pressure. But there was a very rapid drop of pressure as the steam passed through the diaphragms, and in consequence leakage occurred at the holes in these through which the shaft passed. The great point was, however, that, given two turbines of the same design, and but one, say, ten times the power of the other, the larger turbine could not only run at one-fifth of the revolutions, but the percentage of steam lost by leakage would at the same time be one-half that lost with the smaller turbine; and that followed directly and necessarily from the simple increase in the diameter of the turbine. The first speaker had referred to the high vacuum asked for by turbine makers as if it were an indispensable requisite of the turbine; the real fact being, of course, that, as the relation of pressure to volume showed a slight reduction in the terminal pressure, when near the bottom of the scale, it added enormously to the available energy of the steam; and of that, whilst lost on the reciprocating engine, the turbine could take full advantage.

Mr. Barker, engineer of the Parsons Steam Turbine Company, speaking on the question of vacuum, said that going from 27 inches to 28 inches was an increase of 5 per cent. in the power developed; extra speed was given to the circulating water. The question to be settled was, what was the greatest amount of power that could be generated with a given amount of coal? In other words, what could they afford to pay for power? He would ask the author whether there was any trouble from deterioration of the internal parts of the Rateau turbine. In the Parsons turbine they had no difficulty, but the velocities of steam with M. Rateau's turbine were considerably higher, and he thought there might be some trouble in this respect. He anticipated, also, that the cost of repair would be greater with the Rateau turbine, and there would be more difficulty in executing repairs at sea. Governing was not so much a question affecting marine work as of electrical generation; but they were able to work within 1 per cent. to 1 1-2 per cent. of the normal. Could this be effected by the Rateau turbine? It would also be interesting to hear what was the consumption of oil. That was a subject which was being pressed on engineers. It was claimed for the Rateau turbine that there was no thrust; but that was actually a drawback for marine propulsion, as the thrust of the propeller was balanced by that of the steam, and, for this reason, with the Parsons turbine they could dispense with the thrust block.

Mr. C. A. Parsons stated that the French engineer Tournaire had published, thirty years ago, a description of a turbine with steam directed radially and outward, as that described by M. Rateau, but the results obtained were not equal to those of the parallel flow. The consumption at no load was high, and at full load it was not good. It was not right, however, to think that there was any radical difference between the two turbines. With the Curtis turbine it was a mistake to suppose there was a loss owing to longitudinal velocity; the loss that existed was due to friction. In regard to very low-pressure steam, about six years ago he had offered to take the engines out of the *Ireland* and put in steam turbines indicating 2,000 horse power more; that is to say, to go from 6,000 horse power to 8,000 horse power. The leakage in large turbines of 300 to 500 horse power, and above, was not serious at all—about 5 per cent. This had been ascertained by careful measurement, and the loss was about one-fifth of that due to condensation in the cylinders of ordinary engines. With the smaller sizes of turbines, however, the loss through leakage was serious. They had tried every possible device to get over this, but were always disappointed, skin friction being more than an offset for anything gained by checking the unobstructed flow of steam. They had succeeded in stopping the leakage, but the turbine was 15 per cent. less efficient than when no efforts were made in this direction. It would be interesting to know what were the results obtained with the torpedo boat built for the French navy and propelled by Rateau turbines. In regard to the parallel-flow turbine, he thought the success was sufficiently proved by the fact that such engines, of many thousands of horse power, had been made for driving dynamos, especially alternators, and had been successfully used for very many years; for the business of making them was by no means a new one.

M. Rateau's rejoinder in closing the discussion will be given later.

Foreclosed Mortgage.—A suit to foreclose the mortgage of $16,000,000 on the property of the United States Shipbuilding Company was commenced in the United States court at Trenton against James Smith, Jr., receiver, by the Mercantile Trust Company of New York as trustee. The only property of the United States Shipbuilding Company not covered by the mortgage is the Bethlehem Steel Works, on which a mortgage of $10,000,000 was previously given to the New York Security and Trust Company as trustee for the issue of gold bonds. It is alleged that the shipbuilding company defaulted the semi-annual interest of $400,000 due July 1, and a further sum of $200,000 which was to go into the sinking fund for the retirement of gold bonds.

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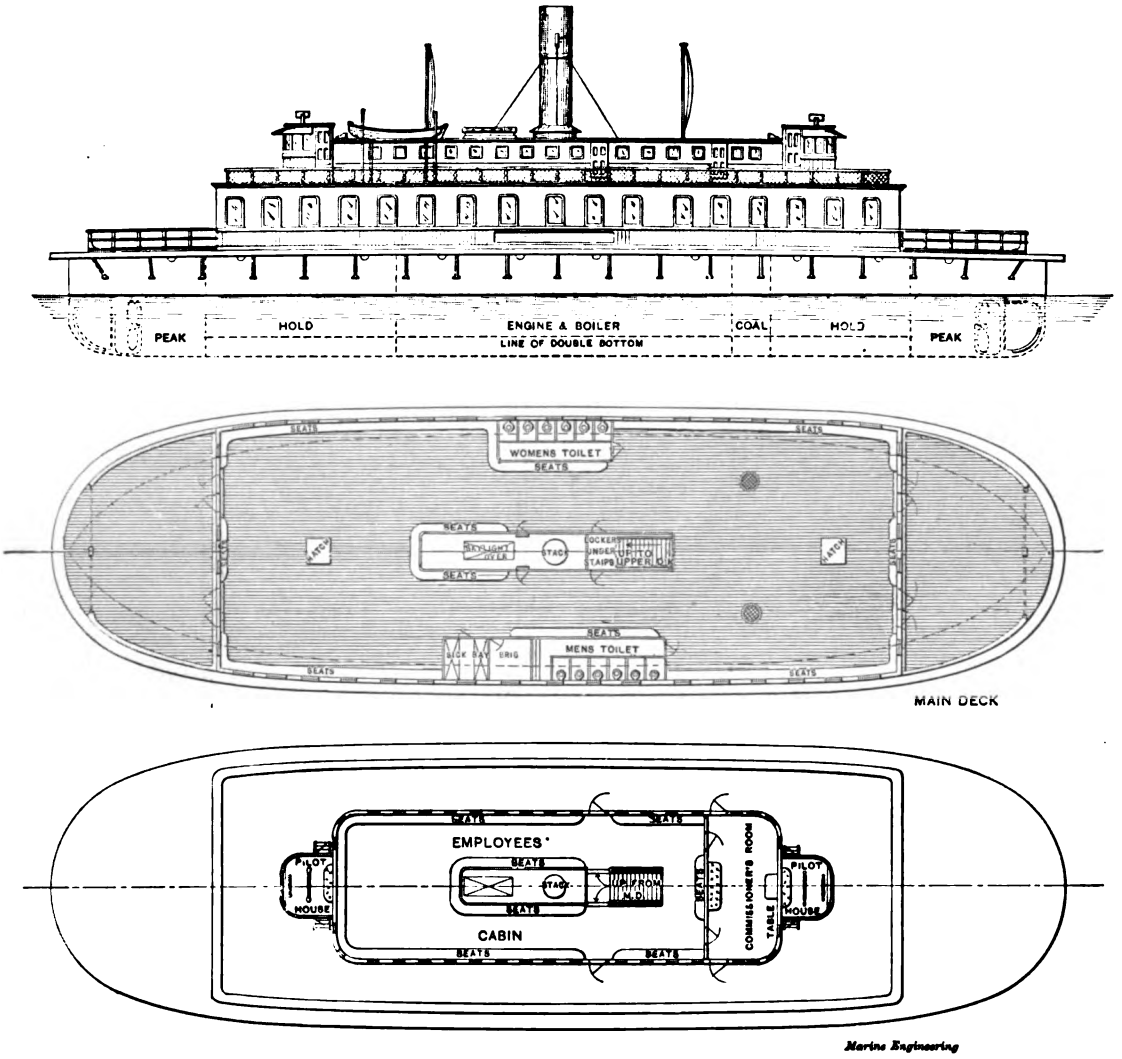
ELLIS ISLAND FERRYBOAT.

The contract for the design and building of a new ferryboat to run between the Barge Office and the United States Immigration Station at Ellis Island, New York harbor, has been awarded to the Harlan and Hollingsworth Company, Wilmington, Del., one of the constituent companies of the United States Shipbuilding Company. The boat is to be ready for service the latter part of the winter, and will take the place of the old side-wheel steamer *John G. Carlisle.*

CONSTRUCTION.

The hull and center house are to be built entirely of steel, and the five water-tight bulkheads are located as shown on the accompanying plan. The keelson is a continuous vertical plate, 42 inches deep, made up in as long lengths as possible of 17 1-2-pound material. The butts of the keelson are to have double straps treble-riveted. The keelson extends 6 inches below the base, and two side bars, 6 inches deep and 30 pounds per square foot, together with the lower edges of the



ELEVATION AND DECK PLANS OF THE NEW ELLIS ISLAND FERRYBOAT, TO BE BUILT BY THE HARLAN AND HOLLINGSWORTH COMPANY, WILMINGTON, DEL.

The specifications and drawings call for a double-end ferryboat driven by two screws, one at either end. In designing the boat the Harlan and Hollingsworth Company has endeavored to make the general appearance good and at the same time have the arrangement and detail such that they conform in every way to the special service required.

The dimensions of the boat will be found in the data card, and the length over all is 160 feet. The draft is specified not to exceed 9 feet 3 inches, and the service speed must be at least 12 statute miles per hour.

two garboard strakes, form the outer keel. The vessel is to have a double bottom 36 inches deep at the center, extending between the collision bulkheads, and must be capable of carrying 15,000 gallons of fresh water when necessary. Each end of the double bottom is to be made into a feed tank for boiler use by fitting a water-tight floor.

The keelson is connected to the 10 pounds per square foot double bottom plating by angle 4 by 3 inches by 8 pounds. The frames are 3 1-2 by 3 inches by 7.9 pounds per foot plain angles spaced 24 inches between

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centers between collision bulkheads. Beyond these bulkheads the spacing is 15 inches. Frames in the double bottom are 2 1-2 by 2 1-2-inch by 5.1-pound angles. The reverse bars are 2 1-2 by 2 1-2-inch by 5.1-pound bars extending along top of floors to deck on alternate frames and to a distance of 6 inches beyond the bilge keelson on intermediate frames. Reverse frames are to be double under engines and boilers; the extra reverse frame extends to the bilge keelson.

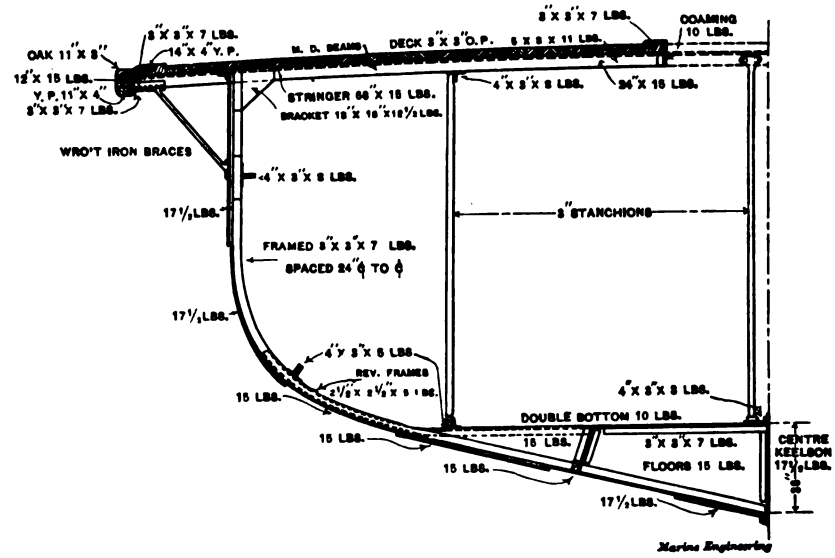
The floor plates are to be 36 inches deep and 15 pounds in way of double bottom, except under engine and boilers, where the weight is 18 pounds. At the ends of the vessel the depth of the floor plates is increased. The floors are connected to the center keelson by double angles, 3 by 3 inches by 7.2 pounds, and to double bottom and marginal plates by single 2 1-2 by 2 1-2-inch by 5.1-pound angles. On each side of the vessel there are to be 4 belt frames, 14 inches wide by 12 1-2 pounds weight, faced with double 2 1-2 by 2 1-2-inch by 5.1-pound angles in one length.

The end post, 6 by 3 inches; the rudder post, 6 by 3 1-2 inches; and the stern post, 6 by 4 inches, are all to be of cast steel. The stern post is to extend 6 feet into the vessel, with a 22-inch scarf for connection to the keel. The rudder frames are to be of cast steel with stocks 4 1-2 inches diameter.

The deck beams are 5 by 3 inches by 11.2 pounds on every frame, and connected to frames by gusset plates 18 by 18 inches by 12 1-2 pounds. Alternate beams extend from guard to guard, and are to be collared where they pass through the sheer strake. The sister keelson, bilge keelson, and side stringer are composed each of double 4 by 3-inch by 8-pound foot angles riveted back to back. They are to extend as far into the ends of vessel as possible and to terminate in breast hooks where practicable. All are bracketed to water-tight bulkheads and not run through.

The shell plating is to be arranged inside and outside alternately. The landings will be single-riveted generally; the sheer to the sides and the garboard to bottom to be double. Butts of shell plates are to be lapped and treble-riveted. The entire sheer and garboard strakes, and the water-line strake for a distance of 100 feet amidships, are to be 17 1-2 pounds. The side, bilge, and bottom strakes are to be 15 pounds. The water-line strake at each end will have plates 20 pounds per square foot.

The main stringer will be 66 inches by 15 pounds, connected to the sheer strake by 3 by 3-inch by 7.2-pound angles. Tie plates 24 inches wide, of 15 pounds weight, will extend along the sides of the center house to the deck plating on each end. In way of the boilers the deck is to be covered by plates 7 1-2 pounds per square foot. On the guards the lower rim plate is to be 10 inches wide by 15 pounds. The face plate is to be 12 inches deep by 15 pounds, secured to the stringer by continuous 3 by 3-inch by 7.2-pound angles at top and bottom, and to ends of beams by clips. The guard braces are to be solid, 2 1-2 inches in diameter, with forged heads and feet to secure them to the guard beams and the sheer strake.



MIDSHIP SECTION OF FERRYBOAT FOR ELLIS ISLAND SERVICE OF THE DEPARTMENT OF COMMERCE AND LABOR.

The five water-tight bulkheads are to be built of 10-pound plates and stiffened vertically by 3 1-2 by 3 inch by 7.9-pound angles spaced 24 inches apart. The horizontal stiffeners on the opposite side are to be angles of the same size, spaced 48 inches apart. Each bulkhead is to be fitted with a hinged water-tight door. Ridge bars of double 4 by 3 inches by 8 1-2 pounds per square foot angles are to be secured to under side of deck beams on each side of vessel by clips 12 inches long. The stanchions, which are to be fitted under the ridge bars and on the center line where practicable, are to be made of 3-inch extra heavy wrought-iron pipe having malleable cast heads and feet.

The engine foundation is to be built up of 25-pound plating, and the double bottom in way of the bed plate is to be strengthened, and hollowed out in way of connecting rod. The coal bunkers, situated athwartships

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as shown on the plan, will contain about 20 tons, and will be filled through two 17-inch scuttles in the main deck. The center house will be of steel and will extend over engines and boilers between main and cabin decks and over boilers only above cabin deck. The plating will be 8 pounds in way of main deck and 6 pounds in way of cabin. All plates to be vertical and stiffened by 4 by 2 1-2 inches by 6.1 pounds per foot T-bars. A steel bulkhead will divide the engine and boiler spaces between the main and cabin decks. The weight of each rudder is to be taken on a foundation plate built in the vessel, and the gag pins will be fitted in holes to the cast-steel quadrants.

In each pilot house will be placed a 36-inch steam-steering wheel and a 66-inch hand wheel. The two wheels will turn together, or may be disconnected below if desired. At each end of the vessel folding wrought-iron gates will be attached to cast-iron gate posts. Twenty brass-framed sidelights will be fitted in the hull.

CARPENTER WORK.

The main decks will be 3 by 3-inch Oregon pine, fastened to the deck beams by 1-2-inch galvanized bolts. The main planksheer and the coaming around the center house will be of yellow pine. The rail is to be of white oak with T-bars 2 by 2 inches fastened on top. The fender around the vessel will be of yellow pine, 4 by 11 inches, faced with a white oak wearing piece 3 by 11 inches.

JOINER WORK.

The outside of the lower house will be staved with white pine to the height of the rail. Above the rail the white pine tongue and groove will run fore and aft. The inside of the lower house is to be paneled with burlap with oak trimmings. The center house will also be paneled with burlap with oak trimmings and will be efficiently insulated. The outside of the upper house is to be staved with white pine to the under side of the windows, and above that point to be paneled. Above the seats in the upper house will be panels of burlap with oak trimmings. All window frames, doors, and seats will be of oak. The upper deck, which is to extend between pilot houses to the sides of the vessel, will be white pine tongue and groove covered with canvas and painted. The commissioner's room on the upper deck is to contain a large upholstered seat and a swinging table.

On the lower deck on one side will be the women's toilet, and on the opposite side will be the men's toilet in addition to a brig and a sick-bay containing four permanent berths. In the hold will be berths for 8 men. The entire upper deck to be enclosed by wire mesh fitted to a hard-wood railing.

MACHINERY.

The vessel will be propelled by a compound surface-condensing engine. The diameters of the cylinders will be 18 and 36 inches with a common stroke of 24 inches. The high-pressure cylinder will have piston valve and the low-pressure one double-port slide valve. The Stephenson link type of valve gear will be used. The crank shafts will be of the built-up type, and the thrust bearings of the horseshoe type with collars of cast iron faced with brass. The condenser will be rectangular, of cast iron, and will contain 950 square feet of condensing surface. There will be one centrifugal circulating pump, one vertical twin-cylinder air pump, one vertical duplex brass-lined feed pump, one horizontal duplex brass-lined fire pump, and one horizontal duplex sanitary pump. The propellers are to be of cast iron, 7 feet in diameter.

There will be two single-end Scotch boilers, 10 feet in diameter and 12 feet in length, to be constructed in accordance with the United States Inspection requirements for a working pressure of 135 pounds. Each boiler will have two furnaces, of the Brown latest type, connected to a single combustion chamber. The grate surface of the two boilers is to be 82 square feet, with grate bars 6 feet 6 inches long. The heating surface in the two boilers will be about 2,280 square feet.

The vessel throughout will be lighted by electricity and heated by steam.

New Marine Railway.—A new composite steel marine railway dry-dock of 3,000 tons capacity, for Hall Brothers, Port Blakely, Wash., has just been completed. The engineers and contractors for the work were H. I. Crandall and Son Company, 102 Border street, East Boston, Mass.

NAME—	NATIONALITY—American. TYPE—Harbor propeller, ferryboat.
LAUNCHED—	BUILDER—Harlan and Hollingsworth Company. OWNER—Dept. Commerce & Labor.
Length over all	160 ft.
" " stern posts	154 "
Beam at deck	37 "
" over guards	45 "
Crown of deck beams	6 ins. in 45 "
Depth at center	15 ft. 3 ins.
Draft	9 " 3 "
Displacement	660 tons
Block coef.	.43
Engines: Number	1
Type	compound
Cylinder diams	18 and 36 ins.
Stroke	24 "
Valves	piston on H. P.; slide on L. P.
I. H. P., designed	450
Rev., "	120
Speed, "	10.3 knots
Condenser surf	950 sq. ft.
Boilers: Number	two single-end Scotch
Diameter	10 ft.
Length	12 "
G. S. total	82 sq. ft.
H. S. "	2,280 "

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REMARKABLE RUN OF THE KEARSARGE ACROSS THE ATLANTIC.

That the accredited trial speed of warships is fictitious, so far as that to be attained under service conditions, has more or less been generally assumed, but in the American Navy some most brilliant exceptions to this statement have been made, such as the world-famous trip of the *Oregon*, to show that the trial speeds obtained on our ships are not only within the province of possibilities, but that they may be actually secured.

The most recent and, in a way, remarkable of the long fast runs of our warships was performed by the U. S. battleship *Kearsarge*. She left Portsmouth, England, on July 17, passing The Needles, the point of departure, at 1:30 P.M., Greenwich time, and arrived at Frenchman's bay, on the coast of Maine, at 12:45 P.M. on July 26. The distance covered by the ship was 2,885 nautical miles, and the time, 219 hours 30 minutes, giving a corrected average speed of 13.1 knots for the total run. This run was made under natural draft and accomplished in the face of head winds and head seas, icebergs, dense fog, and a gale. It is probable that, had the ship been going eastward under similar conditions, she would have averaged a speed of 14 knots, for by careful standardization of the screws the revolutions on this voyage should have given her a speed of 13.6 knots.

The only incident in the engine room of any kind was that, shortly after leaving, the wrist pin on the high-pressure port engine became heated, owing to an oiling tube clogging up. The bearing was quickly cooled down and no damage resulted. Head winds varying from 3 to 6 miles were encountered on seven of the days, and on another day a gale washed the seas over the forward 8-inch turrets, necessitating slowing down to about 10 knots for 4 hours. While off the Banks, on account of the presence of icebergs, the speed had to again be cut down to 10 knots for a period of 10 1-2 hours. The presence of the bergs was detected by the drop in the temperature of the water when the weather was foggy, for it was impossible during a greater part of the time to see a ship's length ahead. After running out of the fog, strong adverse currents were encountered for most of the run, it being estimated that on one day this head current amounted to 23 miles.

In commenting upon the results of the run, it should be borne in mind that the *Kearsarge* had been in active service for 44 days previously, having steamed in this time 5,000 miles. Twenty-three days had been spent in steaming, 4 days were occupied by coaling, and the remaining days, while in port, the ship was practically open to inspection to all visitors, and the officers and men were offered entertainment by first the German and later the English navies. All spare moments were spent in making necessary repairs, and when the *Kearsarge* sailed on her homeward voyage the *personnel* was not in the best of physical condition.

The *Kearsarge* is a battleship of 11,525 tons trial displacement. She has two sets of vertical, triple-expansion engines, the diameter of the cylinders being 33 1-2, 51, and 78 inches and the common stroke 48 inches. Steam is supplied by 3 double-end and 2 single-end cylindrical boilers with a total grate surface of 685 square feet and a total heating surface of 22,104 square feet. On trial under forced draft the speed attained was 16.8 knots and the horse power developed 10,000. The total weight of machinery is 1,195 tons.

When starting out from Portsmouth she had a displacement of 13,406 tons, and when she dropped anchor in Frenchman's bay her displacement was but 11,995

TABLE OF PERFORMANCES OF H. M. S. GOOD HOPE, U. S. S. COLUMBIA, AND U. S. S. KEARSARGE.

	H. M. S. Good Hope, Nov. 25-Dec. 26, 1902.				U. S. S. Columbia, July 26-Aug. 2, 1895.		U. S. S. Kearsarge, July 17-26, 1903.
	Best day's run.	Portsmouth to Port Said.	Suez to Zanzibar.	Zanzibar to Durban.	Best day's run.	Southampton to New York.	Avg., Needles to Frenchman's Bay, Me.
Total knots run	....	2,905	2,849	1,590	....	3,090	2,885
Day's run, knots	440	376	401	356.5	462	442	314.4
Speed, average knots per hour	18.8	15.7	16.7	14.85	19.25	18.41	13.1
Days, straightaway	....	7.73	7.1	4.46	...	6.98	9.15
I. H. P., main engines	10,639	10,175	8,571	6,600	10,554	9,576	5,205
" aux. machinery	....	....	....	....	..	140	154
Tons of coal per day, all purposes	282	221	254	178	230	212	125.5
Tons of coal per day for auxiliaries		....	....	....	....	11.33	..
Pounds of coal per I. H. P. per hour, main engines	2.3	2.31	2.59	2.34	1.93	1.95	....
Pounds of coal per I. H. P. per hour for all purposes	2.48	2.55	2.69	2.74	2.03	2.07	2.17
Distance run per ton of coal, knots	1.56	1.70	1.58	2	2	2.08	2.47
Pounds of coal consumed per knot run	1,435	1,316	1,419	1,119	1,115	1,074	891
Pounds of coal used per ton of displacement	2.38	2.24	2.42	1.90	3.6	3.5	.918
Estimated relative coal consumption per 1,000 tons displacement at 10 knots	$D^{\frac{1}{3}} S^3$		9.49	....		8.98	

GENERAL FEATURES OF THE THREE SHIPS.

	H. M. S. Good Hope.	U. S. S. Columbia.	U. S. S. Kearsarge.
Displacement, tons.	14,100	7,350	12,700
Length	500	411.5	360
Breadth (load line).	71	58.3	72.4
Draft, mean	26.5	22.4	25.5
TRIAL FIGURES.			
Knots speed	23.05	22.8	16.8
R. P. M.	122.4	131.72	
I. H. P.	31,088	18,509	10,000
Pressure	....	145	....
Boilers	43 Belleville	8 D. 2 S. Scotch	3 D. 2 S. Scotch
Boilers in use	27	all	all

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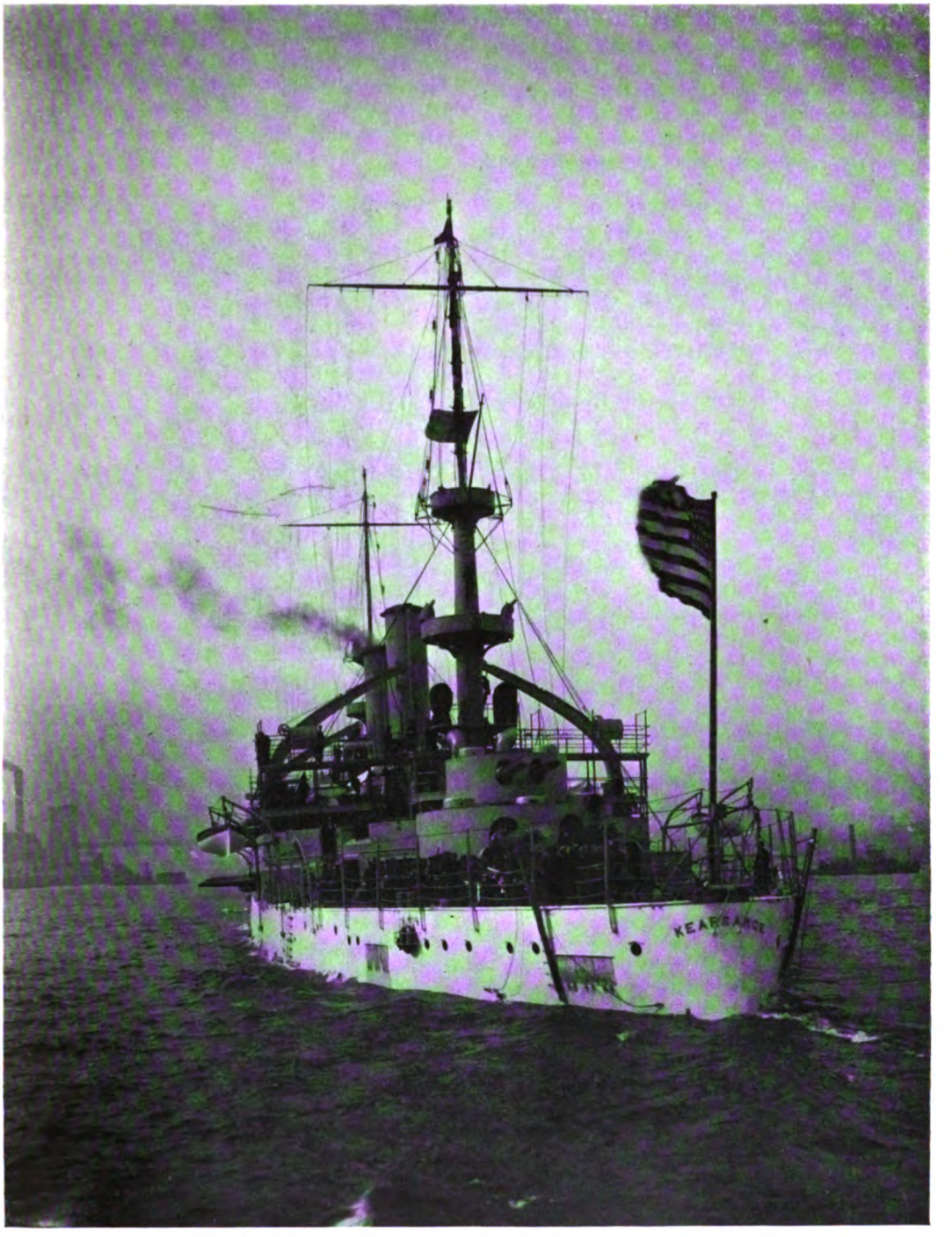
tons, and the mean draft for the voyage was 25 feet 6 1-4 inches. Fifteen hundred tons of coal were stored in the bunkers and 125 tons in the superstructure on deck. Fifty-five thousand gallons of fresh water were carried for making up feed water, in the four double-bottom compartments under the boiler rooms. Thus steam was saved which would otherwise have been required to run the evaporators.

The only overhauling of machinery made necessary at the end of this successful run was cleaning the furnaces and combustion chambers and repacking a few of the main valve stems and the high and intermediate piston rods.



FIRST-CLASS BATTLESHIP KEARSARGE, WHICH RECENTLY MADE A RECORD RUN FOR BATTLESHIPS ACROSS THE ATLANTIC.
[Photograph copyright, 1902, by E. Muller.

In the June number of MARINE ENGINEERING was given a synopsis of the trials of the U. S. S. *Columbia* and H. M. S. *Good Hope*, showing in what particulars *Columbia's* transatlantic record voyage exceeded the trip of the *Good Hope* from Portsmouth to Durban.

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We herewith reproduce the table and add the data taken on this voyage of the U. S. S. *Kearsarge*. It should be borne in mind that the three vessels are of different classes—commerce destroyer, armored cruiser, and battleship.

The length of the first two runs of the *Good Hope* and that of the *Columbia* were about the same as that of the *Kearsarge*. Although the speed of the *Kearsarge* was much less than the other boats, yet the horse power developed was more than 50 per cent. of the trial indicated horse power under forced draft conditions, while that of the *Good Hope* averages about 25 per cent. of trial conditions.

The coal consumed per I. H. P. per hour of the *Kearsarge* was decidedly better than that of the *Good Hope* on any of the three runs, and was within 0.1 of a pound to that of the *Columbia*.

As might be expected, the distance run per ton of coal going at a slower speed shows up favorably for the *Kearsarge*, as well as the other ratios, considering speed and displacement.

Further average results obtained on the *Kearsarge* are as follows:

Revolutions	87 1-2
Steam pressure at engines	124 lbs.
Vacuum, mean	25.4 ins.
Cut-off H. P. cylinder	.62 stb.; .64 port
" I. P. "	.66 " .68 "
" L. P. "	.7 " .7 "
I. H. P., main engines	2,676 stb.; 2,515 port
Auxiliaries	184
Total of machinery	5,375
Coal, quality best Cardiff.	
" pounds per hour	11,668
Heating surface	22,104 sq. ft.
Grate surface	685 "
Cooling surface	14,100 "
H. S. ÷ G. S.	32.27
I. H. P. ÷ G. S.	7.85
H. S. ÷ I. H. P.	4.12
Coal, pounds per hour per I. H. P.	2.17
Coal, pounds per hour per sq. ft. H. S.	.52
Coal, pounds per hour per sq. ft. G. S.	17
Speed of ship throughout voyage	13.1 knots
Slip of propeller	9.3
Maximum for two hours—I. H. P.	7,026
Maximum for two hours—revolutions	97 1-4
Maximum for two hours—speed	14.9 knots

Unfortunately at the present writing it is impossible to ascertain the exact number of men engaged in the fire and engine rooms under Lieutenant-Commander Zane, chief engineer.

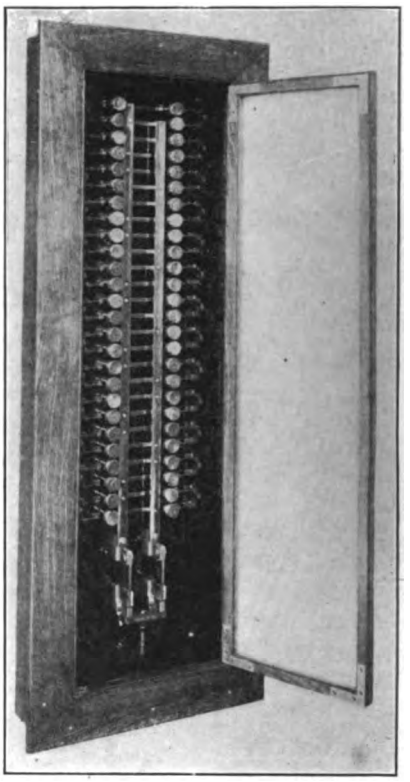
From Captain Hemphill down, all officers and crew are to be congratulated. The *Kearsarge* was built by the Newport News Shipbuilding and Dry-Dock Company.

USES OF ELECTRICITY ON BOARD SHIP.—III.

BY J. W. KELLOGG.

FITTINGS.

For merchant work on the sub-circuits that lead from the distribution points, joints are made where the wires are led off to the individual lights. No. 14 B. and S. wire is generally used for these branch circuits, and joints are made by stripping the wire from 1 1-2 to 2 inches, scraping it clean and soldering after the wires are twisted together. Rosin should be used as a flux, and not acid. It is possible to use acid and get good results.



26-CIRCUIT, 2-WIRE MAIN, WITH 2-WIRE DOUBLE BRANCH CABINET PANEL.

but the slightest careless work will make the joints liable to corrode, and it is generally found that if acid is used the wire is eaten away at the joints and there is continual trouble in the circuits.

After the joint is soldered it is taped up with rubber tape. If the location is damp and lead-covered cables are used, a sleeve of lead is wrapped over the soldered and taped joint. For heavy circuits, where it is necessary to divide or to splice, it is generally better to use a lug, in which the two ends of the cable are soldered, and then the whole taped up as before.

Up to a very few years ago it was customary to run most of the conductors in soft pine wooden moldings. If the wire was located in a damp place lead-covered cables were used. In the English-built ships it has been customary to run the lead-covered cables without any protection along bulkheads and fastened up by wires and cleats. For some ships in this country heavy cables have been led through insulators and through the angles of the frames. At the points where they pass through

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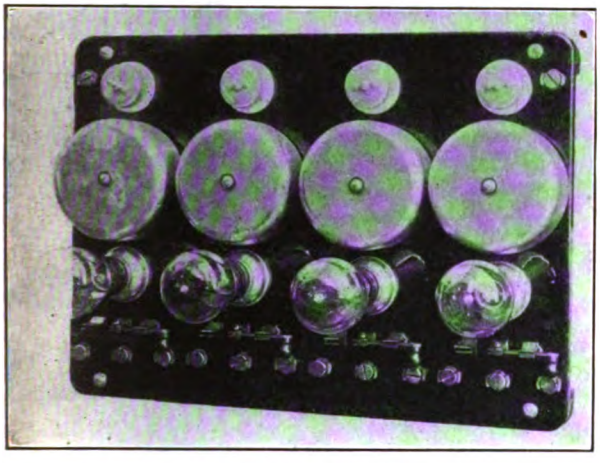
these frames either hard rubber or porcelain bushings were used as a protection to the cables. In exposed places the cables were covered with sheet metal ducts, but generally the wires are simply left uncovered, with the rubber insulation and heavy braid as protection.

Too much care cannot be given to the insulation of the wires to be used on shipboard. The Navy standard requirements are none too good for any of the merchant vessels. The copper conductors are covered first with a layer of pure Para rubber, then a layer of vulcanized rubber containing at least 30 per cent. of pure rubber, and a heavy coating braid placed over this.

It is customary now in all classes of insulation on shipboard to install a large amount of conduit, either steel or iron tubing, through which the conductors for carrying the electric current are drawn. The wires are thus protected from mechanical injury, and if the joints in the piping are properly made the system is water-



RUNNING LIGHT TELLTALE.

tight, and there should be practically no deterioration of the cables due to sweating.

CUT-OUTS, SWITCHBOARDS, AND LAMPS.

For merchant work the ordinary commercial porcelain cut-outs are largely used, though there is a tendency to use specially-constructed panels which have the conductors mounted on one slate panel, and the circuits led off from the main conductors through fuses that are mounted directly on these slates.

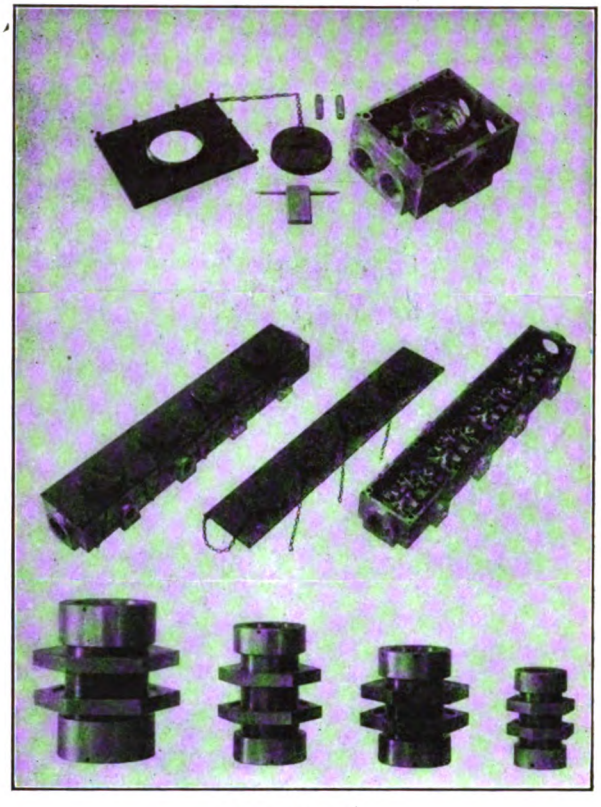
Enclosed fuses are being used at the present time, although until very recently open fuses protected by mica covers were used. For fuses of large carrying capacity, strips of zinc are employed; small fuses are of lead wires. The switches on the distribution boards are usually of small snap rotating type, but with the specially constructed panels, having the copper bars mounted directly on slate, small knife switches with fuse terminals are used.

On the main switchboards, which are usually of slate or marble, bus bars are mounted on the back, to which the main generator cables are connected, and from which connections are made to knife switches and to fuse terminals on the face of the board. The mains and branches are led from these circuit switches.

Incandescent lights are usually from 10 to 32 candle power, the great majority being 16 candle power. What is known as low-economy lamps are generally installed, as the filaments are more substantial and the efficiency is not of as much importance as the life of the lamp. Lamps from 3.4 to 3.8 watts per candle should be used.

SPECIAL LAMPS AND FITTINGS.

In some of the engine rooms arc lamps may be employed to good advantage. These should be of the enclosed type, for use on the incandescent circuits, and



SMALL FITTINGS.

Three-way Feed Junction Box, Fused. Eight-way Marine Distribution Box Stuffing Tubes.

are special marine type lamps, constructed with outer globes protected by wire screens and with the casings practically water-proof. These hung over the cylinders in the engine spaces give a good general illumination in engine rooms. The running lights are usually supplied with two lamps in each lantern, the focus of the Fresnel lens being the point at which the center of the lamp is placed. Small lamps of 4 candle power are supplied for the compasses, being arranged in a socket so as to be placed in the side of the binnacle casing.

In the freight spaces and in the engine and fire rooms and shaft alley it is usual to install water-proof fittings with steam-tight globes over the fixtures. In cargo spaces it is customary to use a large reflector having four or five lamps arranged in a cluster and protected by a heavy wire screen. These have portable cords attached with plugs on the ends, which can be inserted in receptacles that are located outside of the cargo spaces. When the hatches are closed and it is not desired to use

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the lights in these spaces, current is entirely shut off from them.

ELECTRICALLY-DRIVEN AUXILIARIES.

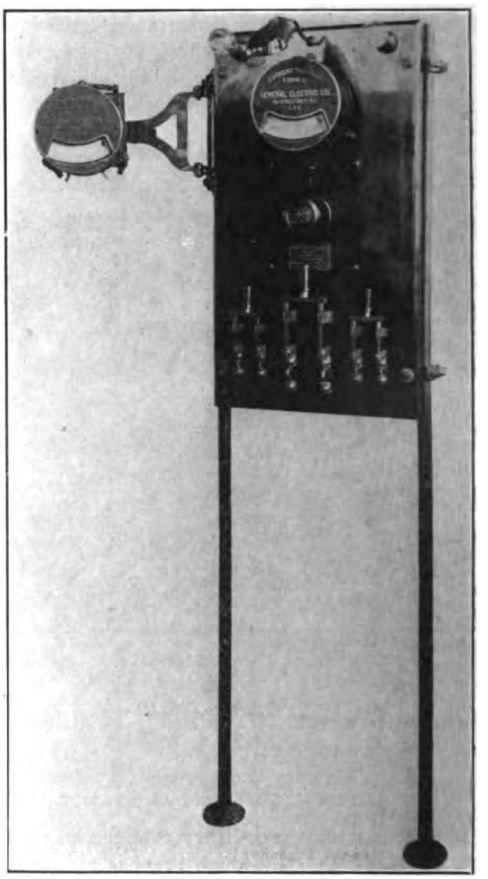
Regarding the motors for auxiliaries, about the first application on shipboard was for operating the valve of the steam-steering engine. This was about as difficult an undertaking as any that could be thought of. The requirements, although calling for small current, nevertheless necessitate some means of making and breaking contacts almost continuously without injury to the contacts. It is also necessary to make a follow-up device, so that the location of the rudder is indicated by the position of the handle controlling the motor on the valve. In spite of the difficulties encountered this was very successfully worked out and a large number have been installed.

FIVE-AMPERE MARINE SWITCH AND RECEPTACLE IN BOX WITH HOOD.

Electricity lends itself very readily to the driving of blowers for hull ventilation. The leads of steam piping into the living spaces are avoided, making it much easier to cool and ventilate. It is the universal practice now to operate the ventilating system by means of electric-driven fans; the fan mounted directly on the extended motor shaft, both being carried on one foundation, making a rigid structure easy of operation, with very little possibility for wear, requiring practically no attention when properly installed.

CARGO WINCHES.

For the cargo winches there have been a few installations in which electric motors have been used. For this purpose the electric motor is also especially fitted. Winches are usually located where, if they are to be steam driven, it is necessary to carry steam pipes throughout the length and breadth of the ship. These winches are used intermittently, and when not in operation it is supposed that steam would be shut off from the pipes leading to the different winches. It is well known that when steam is again turned on, the pipes are found to be leaky, and it is almost impossible to keep them tight; much damage results to the cargo and the spaces are heated unduly. With the electric motor the steam is all confined to the main generating station; there is no deterioration of the conductors, whether the current is on or off; there is no heating and no waste from radiation in the steam pipes extending over long distances; and it is a fact that electric winches, as constructed to-day, are operated with the greatest ease.



SMALL PLANT SWITCHBOARD PANEL.

WINDLASS.

For operating the windlass I believe there have only been two applications, and those in the case of small yachts. Here is a case where the electric motor could be installed to the very best advantage. In any ship's plant there is always sufficient reserve capacity that could be called upon when it was desired to operate the windlass. This occurs very infrequently, and an entirely enclosed water-proof motor, mounted on the bed of the windlass—on the same base, as with a steam engine—could be relied upon to perform its work under all conditions, with the assurance that it would always be ready when wanted. By having the generator for driving the windlass arranged so that only a certain amount of current could be supplied, the motor would operate

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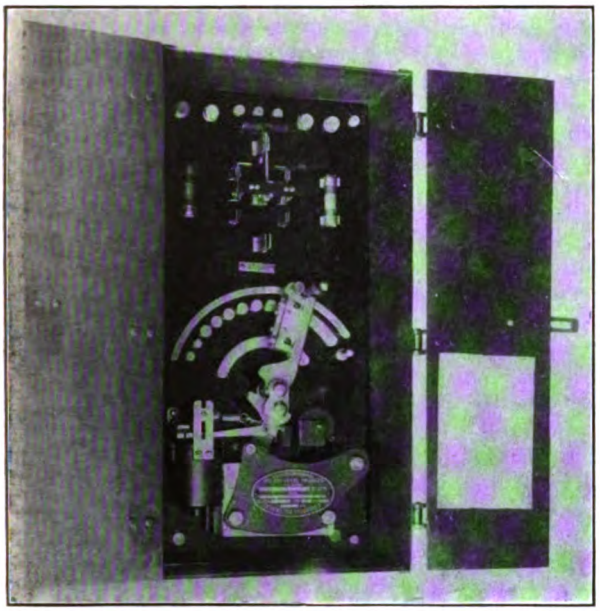
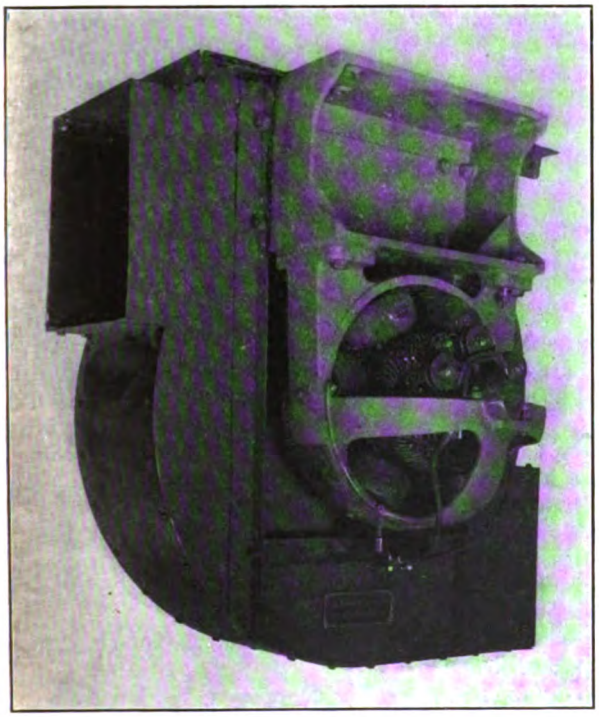
without bringing any undue strain upon the mechanical parts of the windlass or the chain, and would automatically respond to any increased or decreased load brought upon it.



MOTOR-CONTROLLING PANEL FOR THE U. S. S. DENVER.



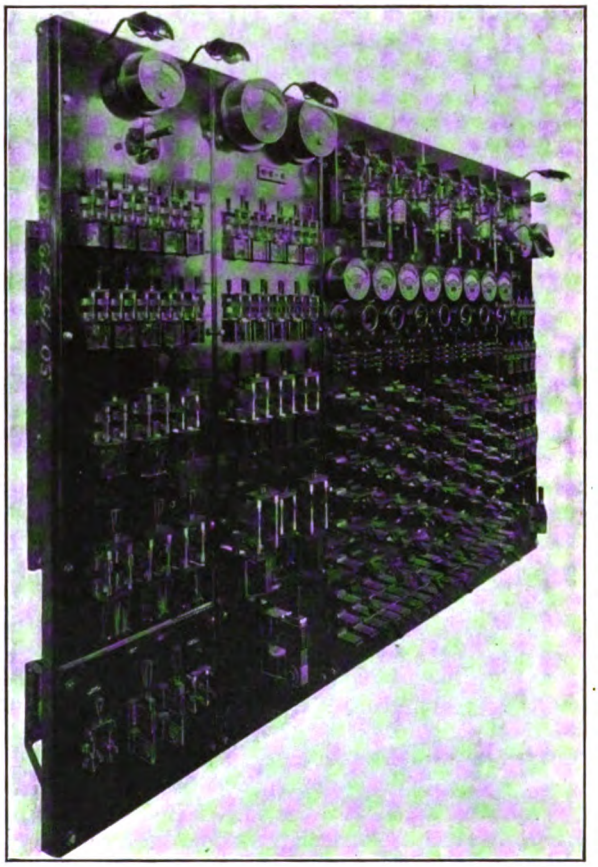
SIX AND ONE-HALF HORSE-POWER, 80 VOLT, VARIABLE-SPEED MOTOR, DIRECT-CONNECTED TO A 55-INCH STEEL PLATE FAN, ON U. S. S. FLORIDA.

Bilge pumps have been supplied on some few ships, but thus far the engine-room auxiliaries have never been equipped electrically. There is a good field for the electric drive even here, as motors could be operated under all conditions of load and could be connected to feed pumps, circulating pumps, forced-draft blowers, air pumps, etc., with the assurance that the system would prove satisfactory.

It is confidently believed that with the introduction of the steam turbine for driving the electric generators, thus enabling a very large plant to be installed in a small space with very little added weight and at a comparatively low cost, it will be found very convenient to call upon a central electric plant for all auxiliary purposes on shipboard.

STORAGE BATTERIES.

On board steam yachts, where light is needed at all times of night, but where cruising is usually done only



PANELS FOR THE U. S. S. MISSOURI.

in the daytime, and thus the engineers are off duty at night, it is desirable to install a storage battery in addition to the generator. Many yachts have been equipped with storage batteries, another desirable feature of them being that at night-time, when the batteries carry the load, there is no noise of a steam engine of the generating set to disturb the sleep of the owner.

The batteries in use in this country are of the chloride type, as made by the Electric Storage Battery Company, or by other concerns having some modifications in their plates, but the general style of the battery is the same. The elements are made of lead plates, in which spaces are left for the placing of lead salt, which is reduced electro-chemically to pure metallic lead; the plate is thus finally composed of pure metallic lead. Diluted

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sulphuric acid is used in the cells, having specific gravity of 33 degree Beaumé—a good commercial acid of 66 degrees Beaumé, one part of acid by volume being added to three parts of water. The solution must be cold when poured into the jars with the elements, and the acid should be poured into the water in mixing. Batteries are arranged with a number of cells connected in series, the cells usually mounted in a box, lead lined, and carefully insulated from the hull of the ship.

Covers are provided for the cells, to prevent the acid from flying out, due to the movements of the ship; but there is always more or less slashing, and it is desirable to keep the cells in a compartment where they can be installed in such a way as to be easily gotten at, and where any fumes that may arise can be carried off without penetrating to the other parts of the ship. It is usually customary to charge the battery at such times as the light is not being used. The battery may be connected to the generator through a switch, which, when thrown in opposite direction, connects to the lines. The charging should be carried on at about a constant current; to maintain this the voltage will have to be varied from about 1.7 volts per cell to 2.8. The cells should not be discharged below about 1.8 to 2 volts per cell.

(To be continued.)

Lining Up Shafting.

A correspondent of *Power* recommends the following method of lining up a marine shaft:

A 1-16-inch hole is drilled through forward engine-room bulkhead; hole in stern post bridged and a 1-16-inch hole drilled through bridge, both drilled holes to correspond with shaft center. A light is then placed forward of engine-room bulkhead hole and it can easily be seen through these two 1-16-inch holes. After-tank bulkhead hole is then bridged, a 1-16-inch hole drilled through bridge and bridge adjusted so the light can be seen through these three 1-16-inch holes. Circles can now be described around these holes in the stern post and after-tank bulkhead with the 1-16-inch holes for centers, bridges removed, and boring bar set by circles. Of course any number of intermediates may be erected before bridges are taken out, to get height of seatings, chucks, etc. All errors of a sagging line are thus avoided.

To line from tail-shaft coupling, shaft-alley bearings, of which there is often only one for each section of shafting, are not used. Each length of shafting is blocked on two blocks in such a way that the overhanging ends balance the portion between blocks, otherwise the shaft will sag, throwing couplings out. Faces of couplings are left a little apart for lining up, so a very keen taper wedge can be used between them. If now the after coupling of after line shaft section is central with forward coupling of tail shaft and the taper wedge enters the same distance all around between their faces, tail shaft and after section of line shaft are surely in line, and the next length forward may be proceeded with. When all the shafting is in, engine bed with crank shaft in place is set in the same way, and forward crank-shaft center will correspond with the 1-16-inch hole drilled in forward engine-room bulkhead. Before blocks are removed from under line shaft, shaft-alley bearings are put in place. X.

STEEL TOWBOAT SPRAGUE.

The largest and most powerful towboat ever built for the Mississippi river was recently turned out from the yards of the Iowa Iron Works Company, Dubuque, Iowa, to the order of the Monongahela River Consolidated Coal and Coke Company, Pittsburg, for use in taking down river the immense fleets of coal barges. The *Sprague* is, as seen in the illustration, of the usual stern-wheel type of steamer which predominates on our Western rivers, but her size is very much larger than any boats yet built, her over-all length being no less than 318 feet. The hull is built of steel from the boiler deck down, the general dimensions being as follows: length of deck, 277 feet; beam, molded, 61 feet; beam over guards, 64 feet 8 inches; depth, molded, 7 feet.

To give sufficient strength to this lengthy and very shallow vessel 3 fore-and-aft bulkheads are fitted, and a system of hog chains and braces is built to take up the strains due to the heavy weights resulting from placing the boilers forward and the engines aft. The hog-chain braces are 4 in number on each side of the vessel and rest upon footlands or steps made up of plate and angle securely riveted to the frames. The general arrangement of the hog chains and braces is shown on the drawings on pages 478 and 479. The chains are well secured to the hull, one set of chains also extending to the end of wheel brackets.

CABIN.

On the cabin deck the officers' quarters occupy the space forward from the forward side of the pilot house. They comprise a large hallway, about 18 feet in width, running the full length thereof, and on either side thereof are the various state rooms and captain's office. Each state room is fitted up with a double berth, one above the other, with clothes rack and washstand, and two doors lead from each state room, one into the main cabin and the other on deck. Immediately aft of the officers' quarters, and on one side of the vessel, are the officers' wash room, bath rooms, lavatories, etc., and on the other side are the kitchen and pantries. Aft of the kitchen is a hallway running crosswise of the vessel, and aft of this hallway are located the two large cold-storage rooms. The after part of the cabin is divided into three large compartments fitted up with berths for deck hands and roustabouts. Washstand, bath room, and lavatory are fitted for the use of these men. All the rooms are lighted with electric lights, and hot and cold water is supplied to all bath rooms. The pilot house, as shown in picture, is located above the cabins. It is about 20 feet square. The wheel is 13 feet 6 inches diameter.

Following will be found specifications covering the principal items:

Hull Construction.—The floors are 57 feet long with a radius of knuckle 15 inches and a side-frame flare of 2 feet. The guards are 22 inches

Frames and Floors.—The side frames and floors are channels 6 inches by 15.3 pounds, in one length, spaced 18 inches centers face to face, except where the frames reverse face forming the after body.

Beams.—The deck beams are of 8-inch channels, 15 pounds weight per foot, secured to the frames by tri-

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angular gusset plates 16 inches on the square. Where the boilers are supported there are in addition 8 I-beams, 8 inches by 20 pounds, put together with cast-iron separators. The boiler beams are 1 inch apart when framed. The bow beams are 8-inch I-beams.

Side Strakes.—These are of 8-pound T, secured to frames by clips. Two boiler bearers are placed forward for each boiler, 14 inches wide, 6 inches in the center of box, formed in length to suit the boiler.

Bulkheads.—There are 3 fore-and-aft and 9 thwartship bulkheads of 1-4-inch plate, stiffened by 2 by 3-inch by 5-pound vertical angles spaced 3 feet centers. The cross bulkheads are riveted to frames and beams, stiffened by angles of above dimension spaced 18 inches. The center bulkhead runs to the stem, while the two wing bulkheads run from bulkhead No. 1 forward in line of capstans and extend to the top breast hook within four feet of the deck.

Footlands.—To have four footlands—steps for the hog-frame braces—between wing and center bulkheads, of 3-inch Z-bar 10 3-10 pounds, from bow to stem, secured from frame by 6-inch angle clip, with three rivets in each frame.

Wing Keelson and Stringer.—One wing keelson and one over keelson on each side, of double angles of 2 1-2 by 2 1-2 inches by 4.1 pounds. Stanchion on every beam 3 by 3 inches by 7 pounds, secured in root of Z-bar keelson and wing stringer, with two rivets each top and bottom.

Breast Hooks.—Two breast hooks of 2 1-2 by 3 1-2-inch by 7-pound angle and plate, from forward bulkhead to stem 5-16-inch, side plate 16 inches, and throat plate 24 inches wide, all secured to cant frames by triangular plate gussets 18 inches on square by 10 pounds.

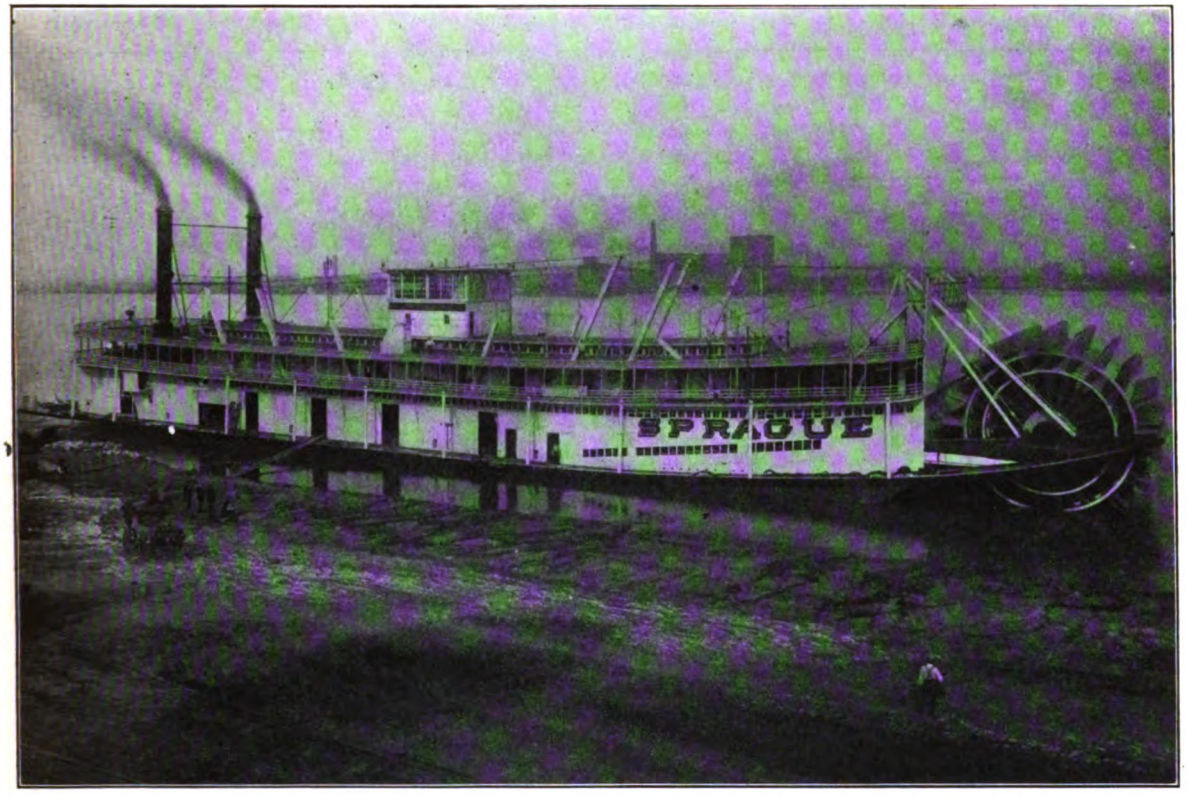
Stem.—2 1-4 by 12-inch forged iron, about 30 feet long, and slotted to receive forward keel plate. The stem plate is of 5-16-inch plate to height of upper hook.

Spar Horse.—26 feet above deck; stock 12 by 12 inches at the deck and 10 by 12 inches at the top; head 8 feet long; two cross arms and two sets of braces.

Stern Posts.—Four stern posts, 2 by 8 inches, with rudder irons forged on same.

Transoms.—One main and one aft transom. The main transom 3 1-2 feet deep, 5-16 inch thick, in two pieces, spliced by plate full width of transom and 4 feet long; stiffened by angles 3 1-2 by 5 inches by 15 pounds. After transom to be secured to main transom by four trapezoidal-shaped brackets of 3 by 3-inch by 6-pound angle and 5-16-inch plate, to form casing of the rudder posts, and carefully riveted to be absolutely water-tight. The stern posts secured to forward side of main transom by 3 by 3-inch by 8-pound angle, riveted to transom and through stern post as may be required, and supported by bulkhead running to forward end of engine beams, well braced.

Rudders.—Four balance rudders; stocks 16 inches diameter, double thick tubing; the blades constructed of 2 1-2 by 2 1-2-inch by 6-pound steel angle forming frame, with a channel beam shoe 6-inch by 10-pound channel, plated with 5-16-inch plate, and stiffened with flanged



STEEL STERN-WHEEL TOWBOAT SPRAGUE, FOR THE COAL FLEETS ON THE OHIO AND MISSISSIPPI RIVERS.

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plate 7-16 inch at intervals of 18 inches, both forward and after blades, and all securely riveted to stocks. Top end of stocks fitted with channel beams, not less than 30 inches long, to receive tillers; said channels to be 12 inches and 16 inches, each stock having the tillers of approved design; two 30 feet and two 15 feet long, constructed of channels, angles, and plate; each rudder having 6 rudder irons, bushed with bronze for a 2-inch shipping rod.

Ash Wells.—Two 12 inches in diameter and 3-4 inch thick, of brass with 2 1-2-inch flange on bottom. The well to extend 2 inches above deck.

Knockers.—2 1-2 by 2 1-2 inches, with 10- and 12-inch plates 1 inch thick on the foot of each knocker, each four bolts 1 inch diameter.

Hull Plating.—Bow and knuckle 3-8 inch thick, of open-hearth homogeneous plate; forward bottom 3-8 inch, balance 5-16 inch, the side plates in two strakes of 1-4 inch, to be double-riveted butts with 5-8-inch rivets, driven neatly and flush with plate. The butt straps are 9 inches wide, 1-16 inch heavier than plates they cover, and to be double-riveted. All butts of plates to be neatly planed on square and planed or bevel-sheared on edges.

Gunwale Bar.—Of angle iron 2 1-2 by 2 1-2 inches by 6 pounds, well secured to top hull plating, deck beams, and planksheer, making same water-tight. The guard to be formed on end of deck beams, 12 by 20.5-pound channel guard rim and 12 by 4-inch nosing; all of approved weight and design, having under planksheer not less than 12 by 1-4 inch. Suitable scuppers for guard.

Fantail.—To be continued to extreme after end of engine beams and to be formed of plate, angle Z-bar and planksheers, and well secured to engine beams by box knees and to hull by approved methods.

Deck.—To be homogeneous 10-pound plate, and the longitudinal seams lapped and single-riveted; cross seams to be butted and double-riveted, bevel-sheared top and bottom.

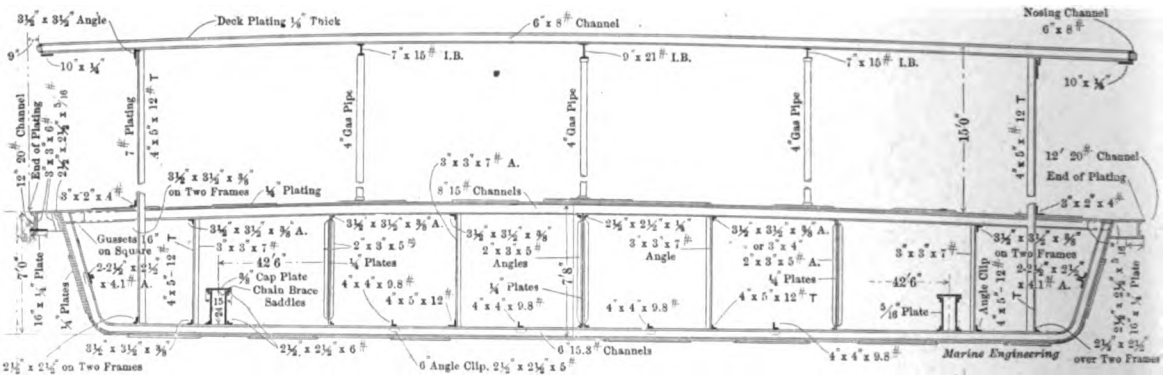
Bulwarks.—To be of angle iron, 2 1-2 by 2 1-2 inches by 6 pounds, and 5-16-inch plate, with a 3-8-inch cap plate of approved design.

Engine Beams.—Two long and two short; long about 110 feet and short about 55 feet; made in box form, 18 inches wide, and of plate 5-16 inch and top plate 1-2 inch and angle not less than 7 pounds, riveted to deck beams and deck, with steel knees between main and aft transoms, and supporting knee on aft transom and well secured to same. The bracing under main engine beams to consist of three stringer angles on each side of floors, and three under beams to aft end of large cylinder and 2 angles thence to main transom, of 4 by 6 inches by 12.3 pounds plates top and bottom, with 18-inch deep and 3-8-inch, provided with diagonal braces 3 by 4 inches by 9.8 pounds, as may be required. Under short beams two similar stringers above and below with diagonal bracing as before. Engine beams to have bulkhead not less than 8 feet centers, of 1-4-inch iron, fastened to web with 2 1-2-inch angles.

Hog-Chain Braces.—12-inch, of channel and plate, with caps to carry 2-inch diameter hog chains; also braces for the wheel and side relief chains. Main brace heels to run from forward end of cylinders to aft boiler beams, constructed of 2 1-2-inch by 6-pound angle, and 5-16-inch webs and 3-8-inch cap plates, of box form, 15 inches wide and 24 inches deep.

Hog Chains.—The hull to have what is known as double chains of 2-inch refined bar iron, with the screw 1-4 inch above the size of iron, with one set of relief chains 1 3-4 inches diameter, with iron braces. Also, the wheel chains of 2 1-2 inches diameter, with braces, caps, and heels of approved design and well secured. The hog-chain fastenings on the hull to be long and well secured to the frame of the boat, and on deck a flange of 1-4-inch plate and angle iron of not less than 12 inches high, and cap to keep dirt and water from the hull.

Cabin Stanchion.—Of 4 by 5-inch by 12-pound T every 6 feet, with two angle stanchions between, secured to the floors by wing castings and to the deck beams by flange castings, which they will pass through and rivet to deck; this casting projecting not less than 1 1-2 inches above deck plate, and the space filled with metal or cement, making same water-tight. The top to be secured to sheer strake by 12-pound T, carlin 6 inches channel 8 pounds every 22 inches, well secured to sheer strake by angle clip. Center stringers 9-inch I-beam, 21 pounds. Two side stringers 7-inch I-beam, 15 pounds. Center stanchion 4-inch gaspipe, with castings top and bottom; nosing 6-inch channel, 3 pound, having



MIDSHIP SECTION OF THE STEEL TOWBOAT SPRAGUE, BUILT BY THE IOWA IRON WORKS COMPANY, DUBUQUE, IOWA.

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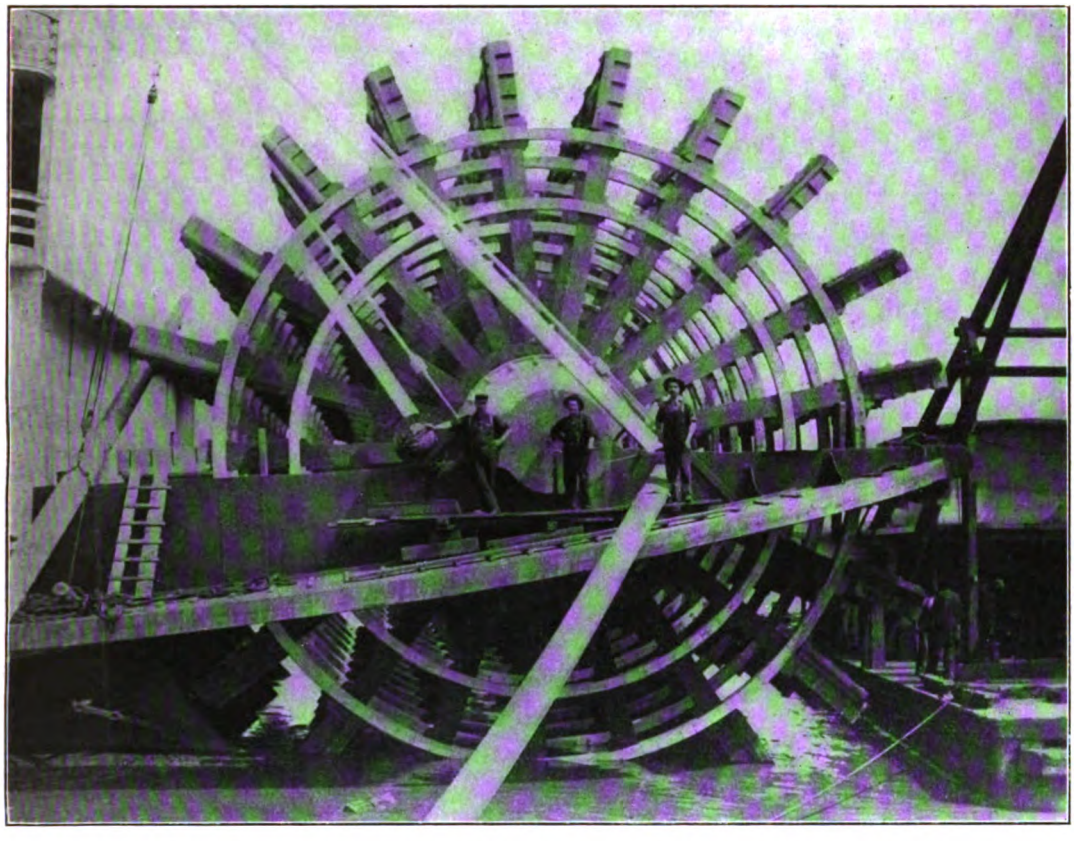
under plankshеer 10 inches 10 pounds, and on same a deck of 1-8-inch plate lapped in and out, and well riveted to the carlin.

Also, three cross bulkheads under large cylinder, one aft, one forward, and one in the middle, constructed of 2 1-2 by 2 1-2-inch by 5-pound angle and 1-4-inch plate; the top angle formed to shape of cylinder, the side bottom angle to conform to deck and web plates of beams, and to be properly staybolted through both webs and beams. Also, cylinder pans for after end of large cylinders of aft end of sides, constructed of 2 1-2 by 4-inch by 1-2-inch T-bar and 5-16-inch plate, stiffened at intervals of 4 feet, and secured to web by rivets and staybolts at intervals of 24 inches, zigzag; also three bulkheads at pillow blocks, one at center and one at each end of same; all bulkheads to be provided with smooth and neat manholes, so man or boy may enter. Also six latticed trusses over boilers, 24 inches at ends, 30 inches in the middle.

The siding, coal box, deck room, and engine room to be plate, 6 pounds, neatly riveted, with doors and windows where desired. Stern bulkhead to be of iron and not less than 3-16 inch thick, well stiffened with angle iron, and to run to top of boiler deck, and above boiler deck 1-8 inch thick.



STERN WHEEL OF STEAMER SPRAGUE, 40 FEET DIAMETER, BUCKETS 4 FEET WIDE BY 40 FEET LONG.

MACHINERY.

The machinery consists of two tandem compound balanced poppet-valve lever engines with California cut-off, each engine working on a crank at the end of the shaft. The high-pressure cylinders are 28 inches diameter and the low-pressure cylinders 63 inches, the common stroke being 12 feet. The pistons are of cast steel and the rods of hammered steel, 9 inches diameter for the high-pressure and 10 inches diameter for the low-pressure. The crossheads are of cast-steel with brass slippers, and the slides are of close-grained cast-iron. The pitmans, or connecting rods, are of white pine 54 feet long, with straps, gibs, guides, etc. The wheel shaft is of hollow forged nickel steel, the outside diameter being 31 inches; diameter of the hole, 21 inches at the center and 10 inches at the journal. The length of the shaft is 47 feet 2 inches, and its weight is 80,220 pounds. It is fitted with 8 cast-steel flanges, to which are attached the spokes of the wheel. The wheel is 40 feet in diameter, with 21 buckets 40 feet long by 4 feet wide. This immense wheel and shaft are well shown in the accompanying engraving.

There is a steam reversing engine with all shafts and levers complete. Water is supplied the boilers by two "doctors" having water plungers 7 inches diameter by 12 inches stroke, with air pump attached 27 inches diameter and 15 inches stroke. There are also two circulating pumps, a fire pump, deck pump, and siphon pumps to comply with the law. Each engine exhausts into a surface condenser, the cooling surface in each being 2,500 square feet. Completing the list of auxiliaries are: electric-lighting plant, complete refrigerating outfit, and steam-steering gear. For warping the ship, hand-

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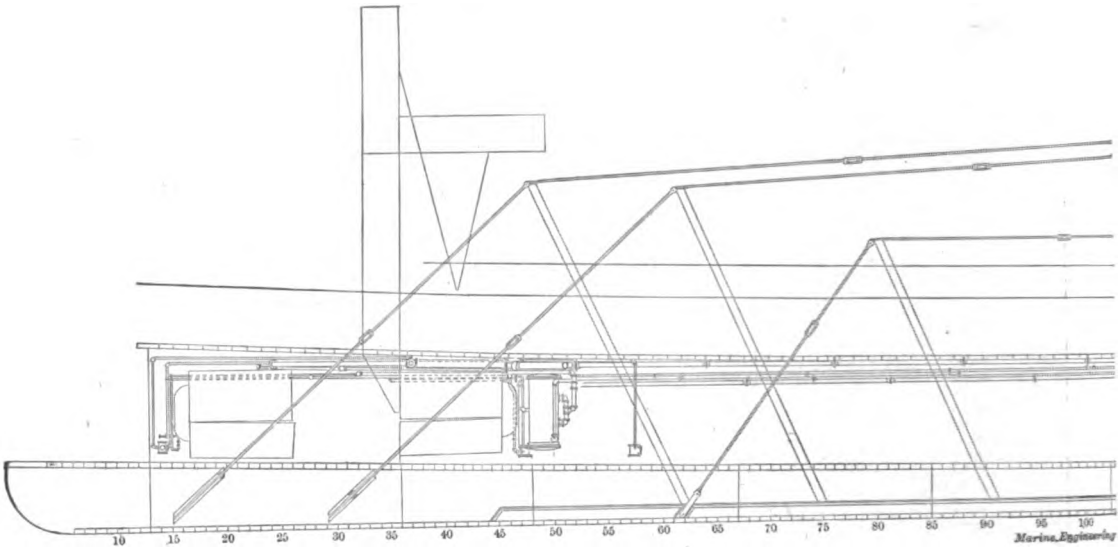
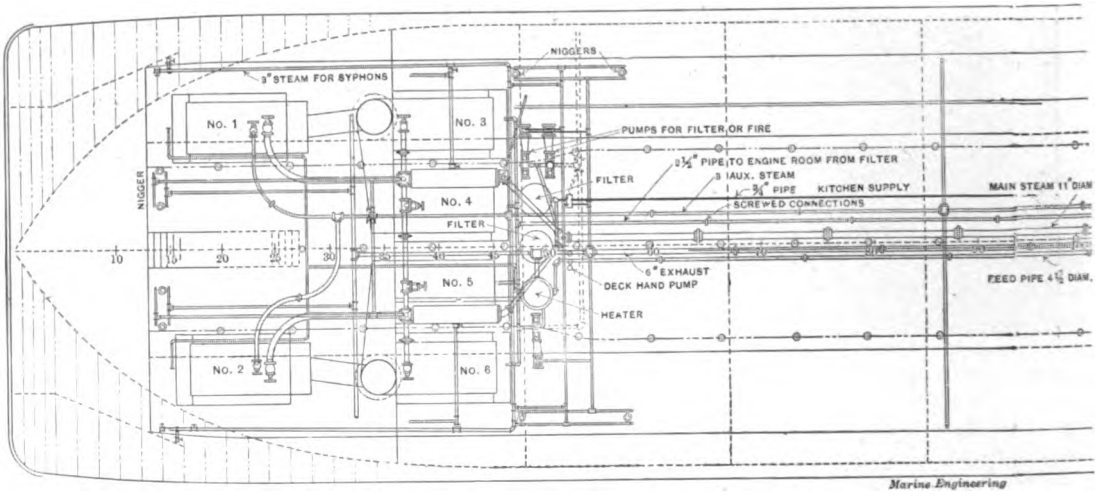
ling gangplanks, etc., there are 7 steam capstans with double 7 by 12-inch engines.

In order to pass under the bridges on the river, it is necessary to lower the smokestacks, so chimney hoists are arranged for this purpose. Each stack is in two sections, the upper section being hinged on the after side, so that it may be swung down.





PIPE PLAN AND HOG-CHAIN PLAN

PIPING.

The piping is shown on the accompanying drawings. The main 6-inch steam pipe is taken off from each boiler to the 6-inch header above the four after boilers. Two steam drums are placed above these boilers between each pair, and through a cross is taken the steam from one forward boiler and two after boilers into each drum. It is thus seen that the size of the piping is held at a minimum. From each drum is led a 4-inch line for the fans and siphons, and niggerheads abreast of boilers, and in the after end of drums steam is carried to the main 11-inch line running aft a distance of 130 feet to the two 8-inch branches to high-pressure cylinders. The exhaust from the low-pressures leads diagonally forward through 18-inch lines to condensers; the pumps for same are on forward engine-room bulkhead. The feed pumps send the water forward through 4 1-2-inch feed line to the closed feed-water heater behind the boilers. To make up the loss of feed water, filters are placed in boiler room and a 2 1-2-inch line leads aft to the feed pumps. The auxiliary exhaust is collected in a 6-inch line leading to both condensers. An auxiliary steam line of 3-inch pipe is carried from each of the two forward boilers to midship siphons and engine-room auxiliaries. Two-inch lines from the header lead to forward niggerheads, filter, and fire pumps, and small take-offs from the main line can supply steam to side niggerheads and cross to the 4-inch line above mentioned.

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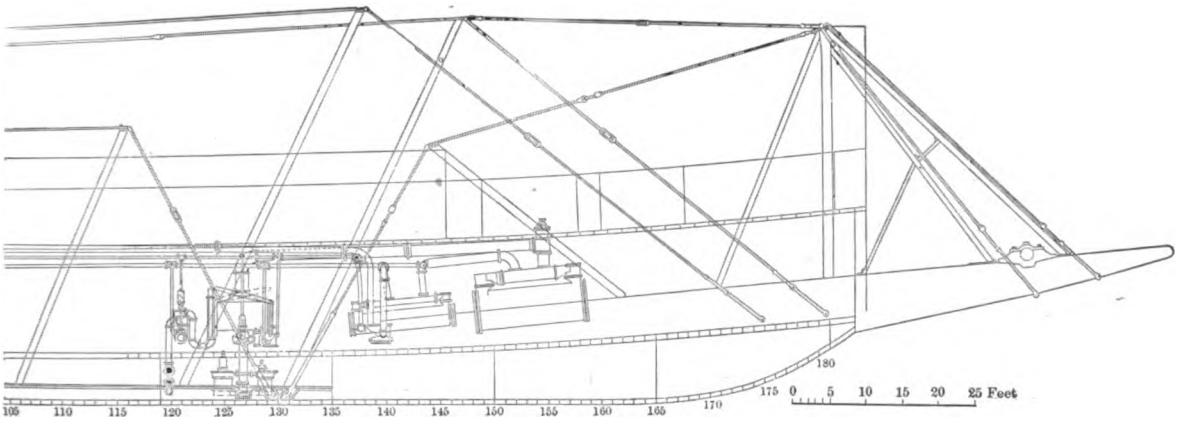
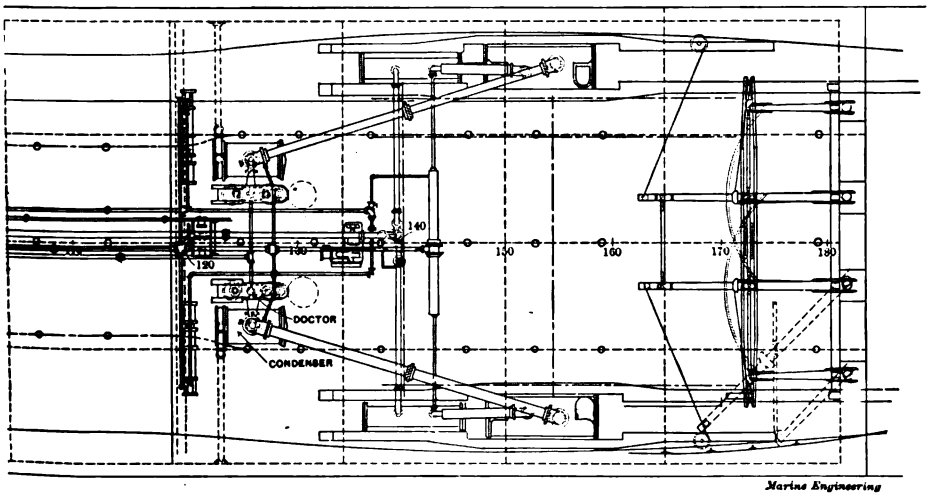
BOILERS.

The boilers, located at the bow, are 6 in number and are of the Hopkins type, as illustrated on page 480. They are equipped with induced draft, the engines and blowers for which were furnished by the American Blower Company. There are two 120-inch full-housed fans with top angular discharges. The wheels are 84 inches in diameter, 46 1-2 inches wide at the center and 34 3-8 inches at the periphery. Direct-connected to each of the fans is an 8 by 8-inch open-frame vertical engine.

The boiler contains many features of interest. First, it is evident that it is a cheaper form than the usual type of marine boiler, as it is without the expensive internal combustion chamber; also, the shell is small in diameter, and, therefore, can be made of light plates. It differs from the Continental type of boiler in that the combustion chambers are mounted in separate shells. As will be seen from the drawing, it is made up of one horizontal tubular boiler and two fire chambers below, connected therewith, extending longitudinally with the boiler shell. These fire chambers or furnaces have each an annular water space, extending throughout the length of and surrounding the entire furnace. This annular water space surrounding the furnace is connected to the tubular member with water legs at the front and rear thereof, the front water leg being somewhat longer than the rear water leg. The furnace used is of the corrugated type. In installing the boilers the tubular member is made level, and the furnace, because of the longer water leg in the front than in the rear, inclines upwardly from the front to the rear.

A sheet-iron combustion chamber lined with firebrick is attached to the rear of the boiler, and the feed-water pipe is carried through the combustion chamber and the rear head of the boiler and discharges the feed water over the smoke flues in the front of the tubular member. The feed-water pipe, before it enters the combustion





OF THE STEEL STERN-WHEEL TOWBOAT SPRAGUE.

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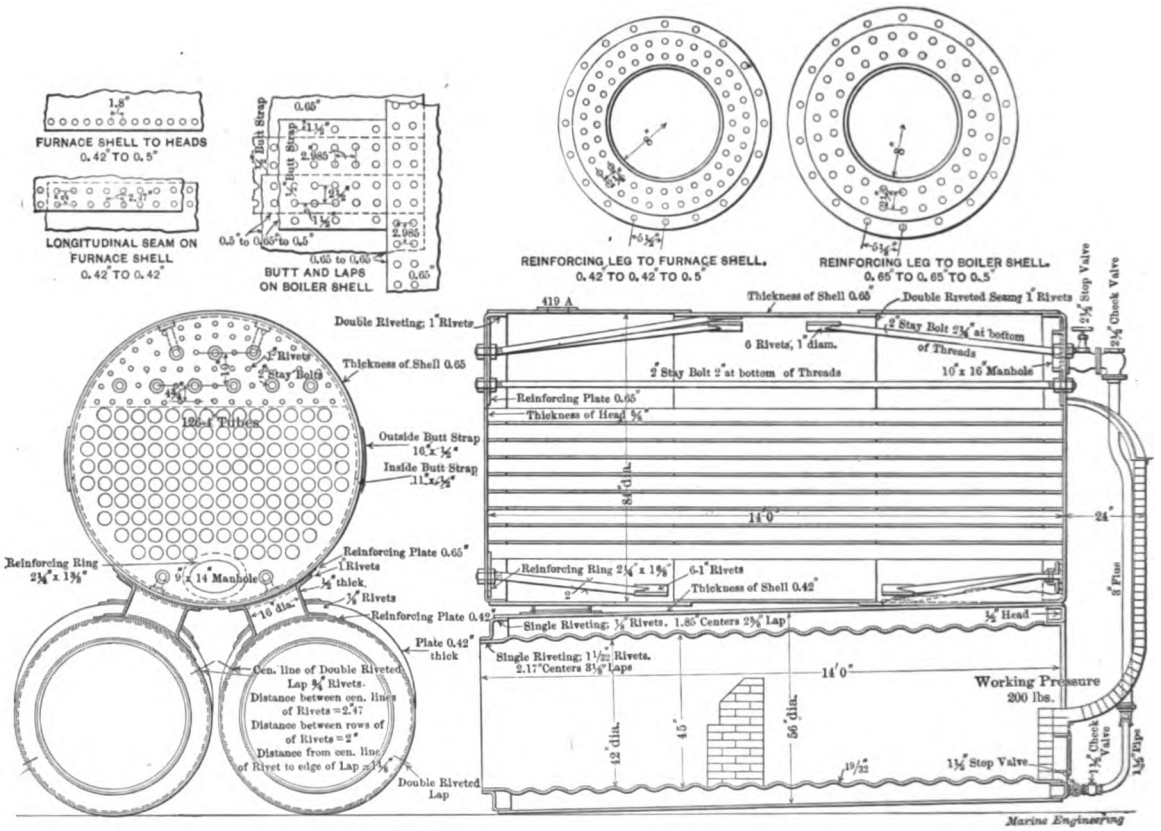
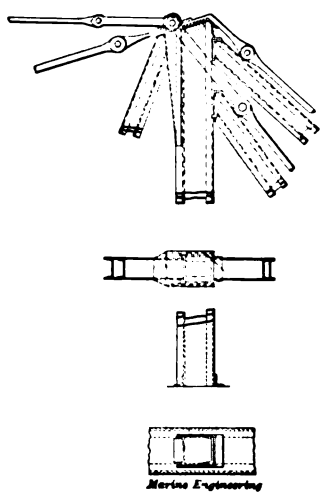
chamber, has connected to it laterals from each of the water spaces surrounding the furnace, these laterals coming from the bottom of the annular water space. Check valves are inserted in each of these laterals to keep the feed water from entering the annular water spaces.

The object in inclining the furnaces from the front to the rear is to create a circulation of water through the boiler. The action of the boiler in operation is as follows:

The fire being started, the water surrounding the corrugated furnace becomes heated and travels along the annular water space until it reaches the back leg; thence it flows upwardly through the back leg into the tubular member, striking the smoke flues and back flue sheet of the tubular member, thence forward through the tubular member and down the front leg into the annular water space, the circulation of water being down the front leg, thence over the furnace, up the back leg into the tubular member. This circulation is also accelerated by having the feed water discharged in the front part of the tubular boiler directly over the front leg, and, as the tendency of the colder particles of water is to settle and the hot particles of water to rise, it results in the feed water being carried down the front leg into the annular water space surrounding the furnace. A circulation is also created by having the feed-water pipe pass through the combustion chamber, as in this manner the water is drawn from the annular water space below the furnace through the two lateral pipes, carried up the feed pipe, and discharged over the front leg. Especially is this the case when the feed pumps are not working. The boiler is provided with manholes in the tubular member, both above and below the smoke flues, and also with handholes for cleaning the annular water spaces surrounding the furnaces. Every part of the boiler is accessible for cleaning.



ONE OF THE SIX HOPKINS BOILERS INSTALLED ON THE STEAM TOWBOAT SPRAGUE.



DETAILS OF HOG-CHAIN BRACES AND HAWSER POST.

Two important features about the boiler are worthy of consideration.

1. The positive and uninterrupted circulation of the water, passing, as it does, down the front leg, thence

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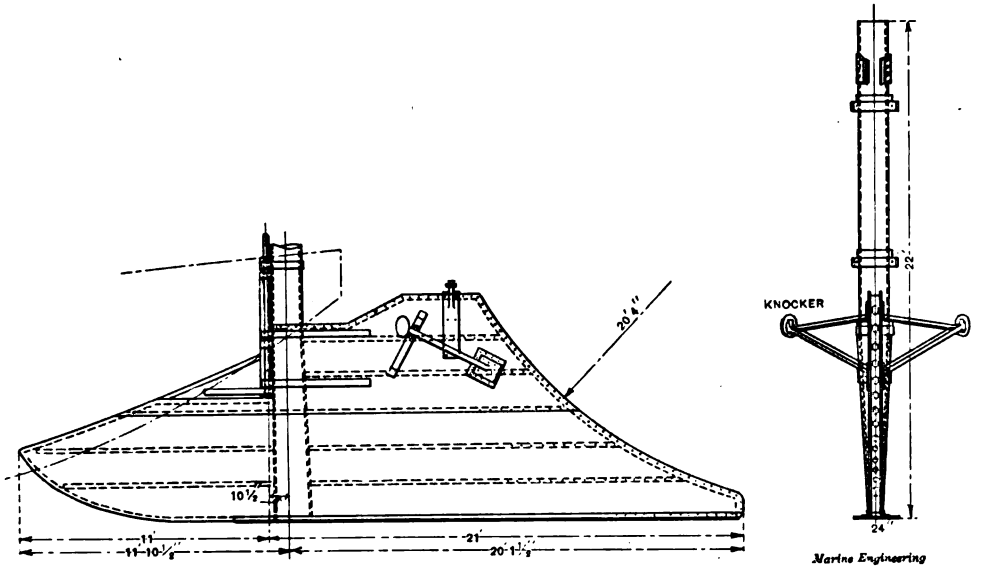
through the water spaces surrounding the furnaces, thence up the back leg and washing the back flue sheet and all the smoke flues connected therewith, thence washing along all the smoke flues through the tubular member, and down the front leg again. This circulation keeps the boiler of an even temperature throughout, thus doing away with any unequal contraction or expansion, and the disastrous results caused therefrom.

2. The sediment which exists in all water is, in the Hopkins boiler, deposited in the tubular members below



ONE OF THE FOUR RUDDERS FITTED ON THE SPRAGUE.

NAME—Sprague.	NATIONALITY—American.	TYPE—Western river towboat.
LAUNCHED—1901.	BUILDER—Iowa Iron Works.	OWNER—Monongahela River Consolidated Coal and Coke Co.

Length over all	318 ft.
" on deck	275 "
Beam, molded	61 "
Depth, "	7 "
Engines: Number	2
Type	tandem compound, poppet valve with California cut-off
Cylinder diams	28 and 63 ins.
Stroke	12 ft.
Rods	9 ins. H. P.; 10 ins. L. P.
Pitman (connecting rod)	white pine, length 54 ft.
Shaft, outside diam	31 ins.
" diam. hole	10 and 21 ins.
" length	47 ft. 2 ins.
Wheel: Diam	40 ft.
Buckets	4 ft. by 40 ft.
" number	21
Revolutions	10
Boilers: Number	6
Type	Hopkins
Diam. of tube shell	7 ft.
" " furnace shells	4 " 8 ins.
Length of shells	14 "
Furnaces: Number	2 each
Diam., mean	45 ins.
Length	14 ft.
Tubes: Number	126
Diam	4 ins.
G. S. per boiler	42 sq. ft.
H. S. " "	2,000 " "
G. S. total	252 " "
H. S. "	12,000 " "
Coal per 24 hours, about	115,000 lbs.
" " hour per sq ft. G S.	19.0 "

the smoke flues. As these parts are not subjected to the fierce heat of the furnace, there can be no bagging or burning of the shell. The sediment is always deposited in this spot because of the circulation which exists in the boiler, there being less disturbance in the water at this part than any other part of the boiler.

Two ash wells are placed in the ash pans of boilers, and consist of straight tubes running down through the bottom of the boat.

From the foregoing it is evident that the hull and machinery of this vessel are very heavy for such a shallow-draft boat. When light the boat draws about 6 feet at the wheel and 5 feet at the bow, and when loaded to push or tow she draws about 6 feet at the wheel and 7 feet 6 inches at the bow. Coal is placed upon the forward deck in order to bring the bow down to this draft, so that the towboat may handle the loaded barges going downstream. In going upstream she carries no load, in order that she may be properly hitched on to her empty barges.

The boilers carry 200 pounds of steam, and there is but very little drop in the long line to the engines. The owners of the boat, who have a fleet of about 80 vessels on the rivers, decided that a large and slow-running wheel was the best suited for this class of work, and therefore the wheel was made, as above stated, of such great diameter and with such large buckets. This cut down the revolutions to about 10 per minute. It is stated that the *Sprague* is the most economical boat on the river, and that an indicated horse power is furnished on 2 pounds of Pittsburg coal.

The very large boiler capacity gives abundant steam for all purposes, which in this class of towboat are not only for the vessel itself, but for running the siphon pumps used to keep the loaded barges free of water.

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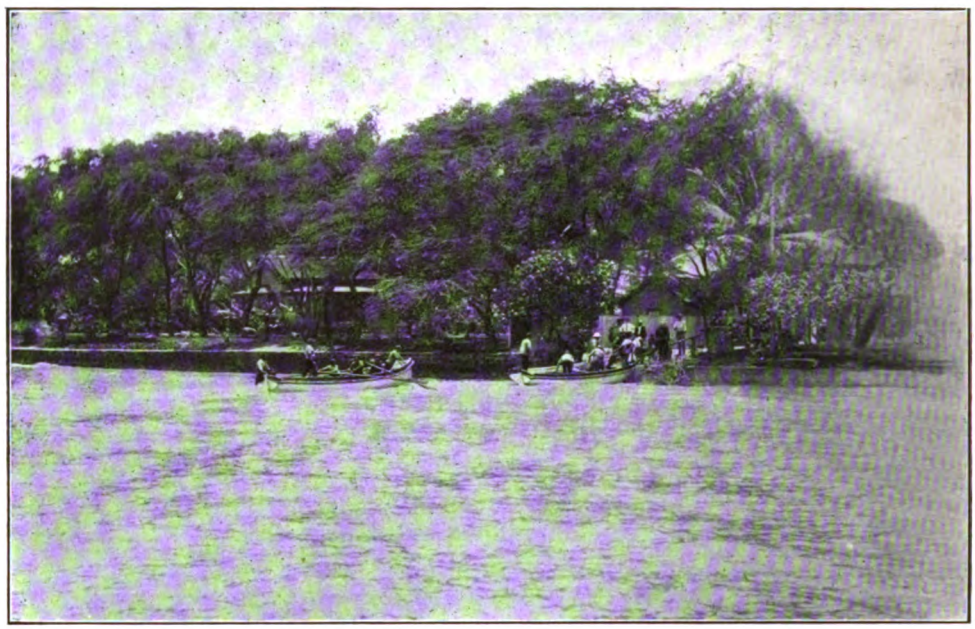
COMPLETING THE TRANSPACIFIC CABLE.

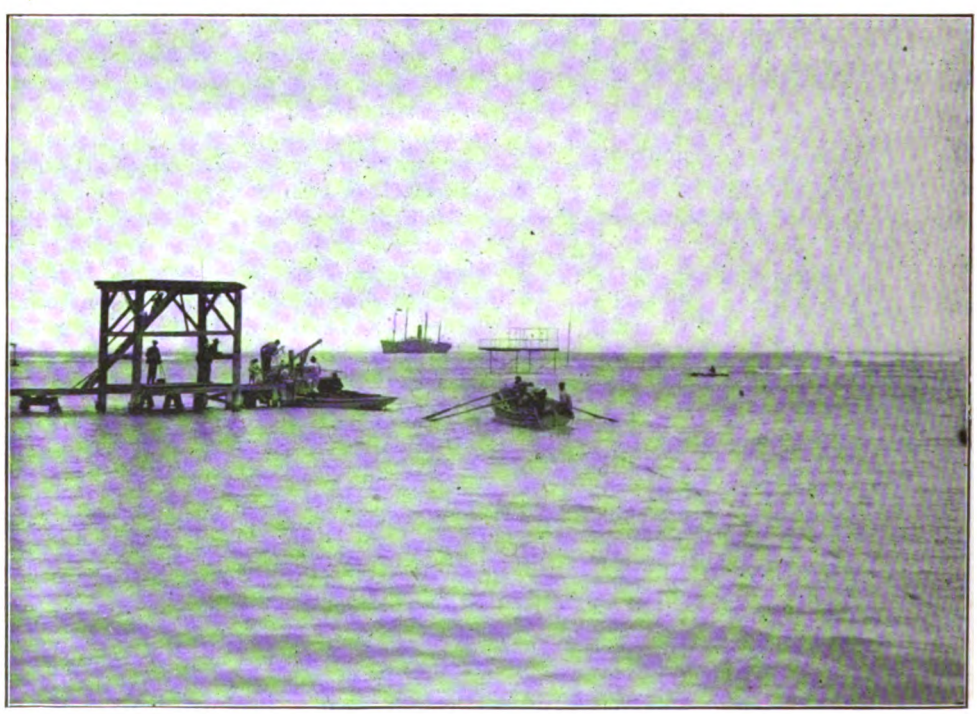
The long-projected enterprise of the American Pacific cable was completed on July 4, 1903, when, as previously noted in these columns, President Roosevelt sent a congratulatory message from Oyster Bay, Long Island, to Governor William H. Taft in Manila. On that day the connecting link at Honolulu was made between two sections of the cable.

The section from San Francisco to Honolulu was completed on December 26 last. Since that time the cable steamers of the Commercial Pacific Cable Company have been laying the sections from Manila to Guam, from Guam to Midway Islands, and from Midway Islands to Honolulu. It was this last stretch of cable, which was connected at Honolulu on July 4, that completed the through line.

A few minutes after the President's message was sent another message was started, this one to go around the



LANDING AT HONOLULU THE TOWLINE TO WHICH THE HAWSER AND LAST STRETCH OF TRANSPACIFIC CABLE WERE BENT.



SPLICING THE HAWSER BY WHICH THE CABLE WAS PULLED ASHORE FROM THE CABLE STEAMER.

[Photographs from Backus Studio, San Francisco, Cal.]

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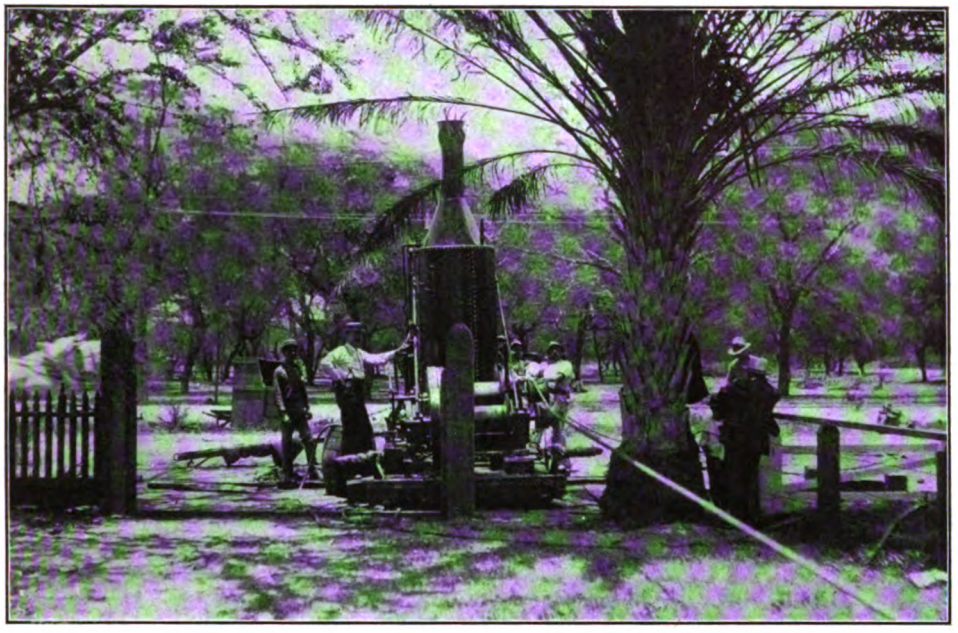
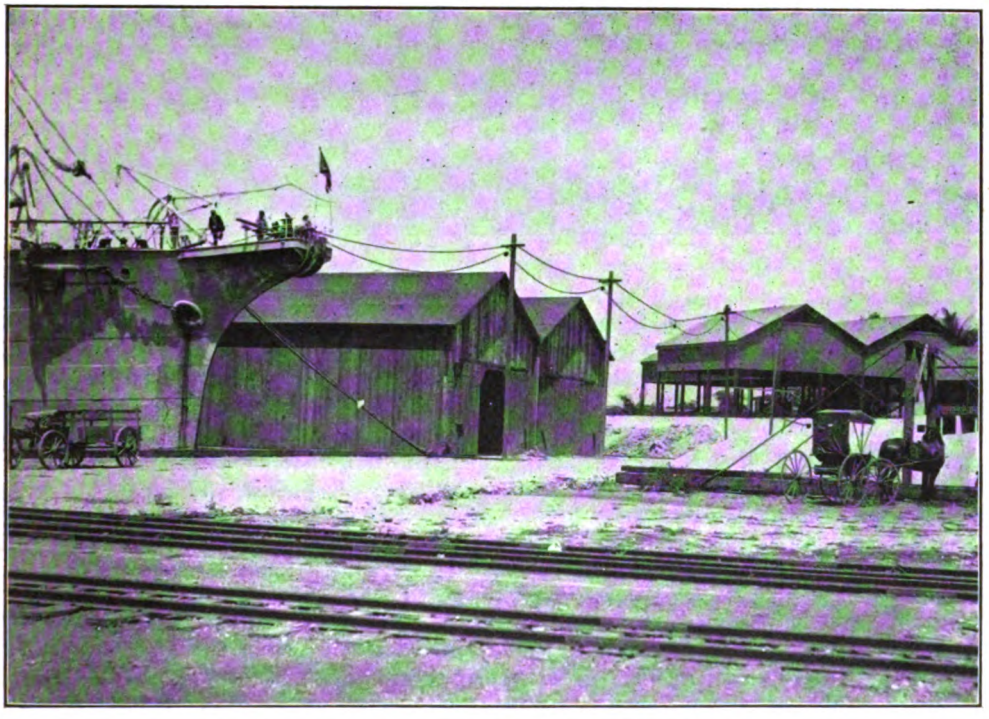
globe. It was from the President and was addressed to Mr. Clarence Mackay, president of the cable company, at Oyster Bay. The message started westward from Oyster Bay to San Francisco; thence over the new cable to Manila, then to Honolulu, Saigon, Singapore, and Penang; thence to Madras and Bombay in India, still continuing westward to Aden, Suez, Malta, Gibraltar, and Lisbon. From this last point it was sent by the transatlantic cable touching at the Azores, Canso, and to New York. The total length of this route was 25,800 miles. The message came ticking back on the receiver at Oyster Bay just 9 1-2 minutes after it had been started.



HAULING THE CABLE ASHORE AT HONOLULU.



CABLE SHIP LANDING UPTOWN SECTION OF CABLE AT HONOLULU.

[Photographs from Backus Studio, San Francisco, Cal.]

The Navy Department several years ago, under the direction of Lieutenant-Commander John Hood, prepared charts of the Pacific ocean from soundings taken of the bottom of the ocean along the proposed line for the cable. These charts were afterward turned over to

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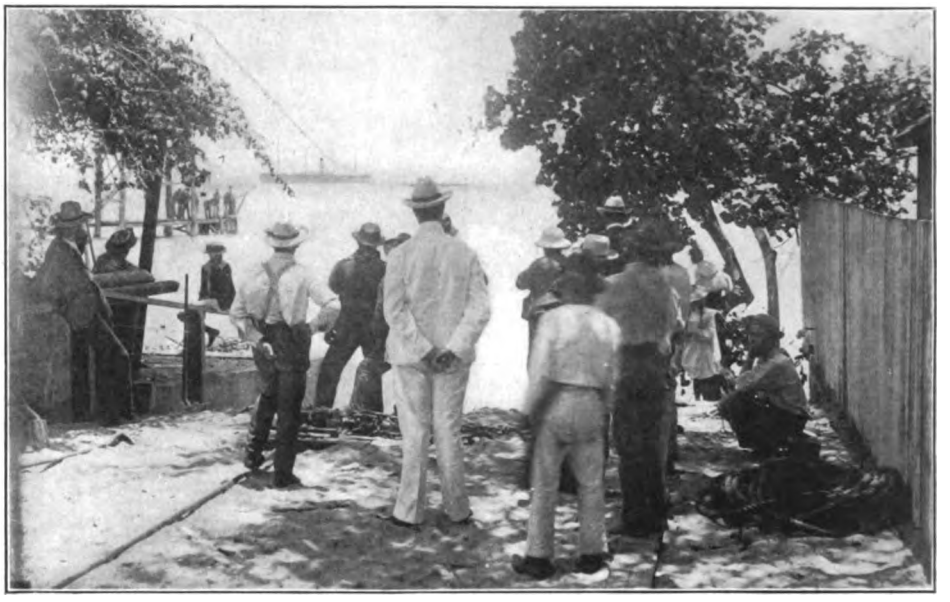
the cable company in exchange for valuable concessions in the use of the cable.

A collection of the parts of the various electrical circuits of historic interest was borrowed from William J. Hammer, and the pieces welded into one and placed in the circuit over which the above messages to go around the world were sent. The collection includes a section of wire over which Professor Morse sent the first message by means of the Morse telegraph; a section of wire over which audible speech was for the first time transmitted by means of the Bell telephone by Professor Bell; a section of the Atlantic cable, through which the first cable message was sent across the ocean by Cyrus W. Field; a section of the wire through which was lighted the first incandescent lamp ever lighted from an electric-lighting central station; and a section of the cable through which the first current of electricity was transmitted from the Niagara Falls electric power plant.

The method of landing the cable on the beach at Sans Souci, Honolulu, is shown in the accompanying engravings. The cable ship anchored off shore and engineers left the steamer in lifeboats to carry the first light line ashore. To this line was bent a heavy hawser on board the ship. The light line was carried up the beach to the hoisting engine, as shown in the engraving on page 483, and when all was in readiness the engine was started and the line drawn in with the heavy hawser attached. The hawser was then wrapped around the gipsy heads of the engine, and the signal was sent to the ship that all was in readiness to bring ashore the cable.

The men on the ship fastened the land end of the cable to the hawser and the cable started shoreward. Casks were tied to the cable every few feet to keep it afloat, as illustrated above. As soon as it was brought ashore it was taken to a small cable house erected on the beach, the end connected to the instruments, the line tested, and then the world-famous messages were sent.



WATCHING THE EFFORTS OF THE ENGINEERS TO LAND THE CABLE.

Water-tube Boiler Tests in the British Navy.

The exhaustive tests to which the two British cruisers *Hyacinth* and *Minerva*, the former fitted with Belleville boilers and the latter with Scotch boilers, were subjected under the direction of the Boiler Committee of the Admiralty, have frequently been mentioned in these columns, and it will be recalled that the test showed up most disparagingly for the Belleville boiler. The two ships were of about the same dimensions, but of different form, and were fitted with propellers of different proportions, all of which gave the *Minerva* about one knot greater speed than the *Hyacinth*, although it was found that the engine friction of the two ships was practically the same. New propellers were fitted to the *Hyacinth*, which resulted in giving her about the same speed as the *Minerva*, the latter keeping her original propellers.

It was then decided first to send the two vessels from Plymouth to Gibraltar at 7,000 I. H. P. and measure the coal and water consumed, the two vessels carrying out the trial in company and continuing until the main supply of coal was exhausted; second, to ascertain the minimum time necessary after arrival in port to coal, make good any defects, clean boilers, and put to sea again; third, a passage trial from Gibraltar to Portsmouth at the highest speed possible, the test to commence with both vessels lying at anchor at Gibraltar with cold water in the boilers.

On February 4, 1903, the two vessels sailed from Plymouth to Gibraltar, the *Hyacinth* completing the voyage in 135 hours and on 898.5 tons of coal, while the *Minerva* took 160 hours and consumed 989 tons of coal. The amount of make-up feed water required on the *Hyacinth* was 170 tons, and on the *Minerva* 183 tons. All these results show in a most favorable light the Belleville boilers of the *Hyacinth*. The machinery on both vessels worked satisfactorily. A pressure of 2 inches of air was maintained on the *Minerva's* boilers, while on the *Hyacinth* it was about .2 inch.

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In the second trial, to determine the time required for coaling and preparing for sea, the *Hyacinth* took 21 hours while the *Minerva* required 45 hours. On the signal being given to light fires and start, the *Hyacinth* got up steam and left the anchorage in 26 minutes, while the *Minerva* took 64 minutes.

The third trial was unfortunately ended by a breakdown of the *Hyacinth's* engines after she had steamed 23 hours. Up to the time of the accident she had averaged a speed of half a knot in excess of the *Minerva*. No defects were noted in the Belleville boilers after these trials.

Another most interesting test of the Belleville boilers was undertaken by the Controller of the Navy. Two cruisers, the *Europa* and *Spartiate*, both fitted with Belleville boilers, were sent from Portsmouth to Hong Kong and back, a distance of 20,000 miles. The idea to be carried out was that, the two ships having been in commission for some time, war suddenly breaks out and before any repairs can be made they are in active service cruising and chasing. Can they in this condition steam 10,000 miles, touching harbor only to coal? The *Europa*, which is accredited with 20 1-4 knots speed and 16,500 horse power, made the run out at 10.75 knots, burning 3,600 tons of coal; and the *Spartiate*, of 20.75 knots and 18,000 horse power, covered the distance at a speed of 13 knots and burned 2,600 tons of coal. On the homeward bound run several full-power 8-hour runs were made, and the *Europa* burned 5,000 tons and the *Spartiate* 4,500, it being stated that the average coal consumption of the two was 1.91 and 1.83 pounds per horse power per hour respectively.

As a result of these two tests the Belleville boiler has evidently regained its prestige with the British Admiralty.

Plans of the 13,000-ton Battleships Approved.

Secretary Moody approved the plans submitted by a majority of the members of the board of construction for the 13,000-ton battleships to be named the *Idaho* and the *Mississippi*. Objections had been raised by Rear-Admiral Bradford, a member of the board, but who was absent from the meeting, against the low speed of 16 1-2 knots and small coal endurance provided for. Rear-Admiral Melville had raised the same objections. The other members of the board are Rear-Admirals Bowles and O'Neil. Our other battleships are of 18-knots speed, and it is claimed that while the new 13,000-ton ships would possess practically the same offensive and defensive powers as our 16,000-ton vessels, yet their smaller speed would be a serious handicap to them. The speed of a fleet is the speed of the slowest vessel.

Rear-Admiral Bowles, who was principally responsible for the designs, has stated as follows:

"In connection with the preparation of the designs careful estimates were made of the radius of action of the principal types of United States battleships built and building, based upon the actual returns of coal expended as compiled from United States steam logs in the Bureau of Steam Engineering. The results of this investigation indicated the number of miles each vessel can steam, starting with full bunkers, at all speeds from 4 to 15 knots. The following table shows the distances at rates of 8, 10, and 13 knots:

	8 knots.	10 knots.	13 knots.
Virginia	3,720	3,820	3,530
Alabama	4,320	4,200	3,500
Maine	4,840	4,900	4,470
Massachusetts	5,050	4,780	4,000
Connecticut	5,270	5,280	4,680
Kearsarge	5,640	5,320	4,070
Idaho	6,000	5,770	4,800

"The design of the modified *Maine* advocated by Rear-Admiral Bradford was intended to duplicate the *Maine's* design in all matters except the disposition of armor and armament, the total weights of the two being the same. This design would, therefore, have the same coal capacity as the present *Maine*, namely, 1,800 tons on the basis of stowage used in these tables. They show that at 8 knots the *Idaho*, with 1,750 tons of coal, steams 1,160 miles farther than the *Maine*, at 10 knots 870 farther, and at 13 knots 330 farther. As a matter of fact the *Idaho* will have greater coal endurance at all cruising speeds than any vessel yet designed. The *Idaho's* great endurance is due to the use of a model adapted to moderate speeds and a consequent low total engine power, both of which reduce the coal burned per mile run."

Lloyd's Register Shipbuilding Returns.

From the returns compiled by Lloyd's Register of Shipping it appears that, excluding warships, there were 426 vessels of 1,028,099 tons gross under construction in the United Kingdom at the close of the quarter ended June 30, 1903.

DESCRIPTION.	JUNE 30, 1903.		JUNE 30, 1902.	
	No.	Gross Tonnage.	No.	Gross Tonnage.
STEAM.				
Steel	397	1,020,381	379	1,107,605
Iron	2	360	1	200
Wood and composite	2	270	1	160
Total	401	1,021,011	381	1,107,965
SAIL.				
Steel	10	5,520	12	20,428
Iron	..	..	..	..
Wood and composite	15	1,568	13	1,189
Total	25	7,088	25	21,617
Total steam and sail	426	1,028,099	406	1,129,582

The present return shows an increase in the tonnage under construction of about 54,000 tons as compared with the figures for last quarter, but a decrease of about 385,000 tons as compared with the total reached in September, 1901, which is the highest on record.

Of these, 340 vessels of 857,342 gross tonnage are built for companies in the United Kingdom.

The division of the tonnage among the principal districts is as follows:

DISTRICT.	NO.	GROSS TONNAGE.
Belfast	20	195,648
Barrow, Maryport, and Workington	13	28,840
Glasgow	78	200,907
Greenock	39	111,260
Hartlepool and Whitby	20	71,771
Middlesbro' and Stockton	27	69,914
Newcastle	76	180,783
Sunderland	37	124,066

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

THE attention of our readers has from time to time been called to the decreasing amount of American tonnage engaged in foreign trade and to the deplorable condition of American shipbuilding. Consideration of this phase of commerce is indeed discouraging and one which the average citizen will postpone to some future day. The facts of the case, however, warrant immediate attention, in order that the remnant of our ocean-carrying trade and our shipyards may be saved.

In 1810, when the population of the United States was about seven millions, 91.5 per cent. of our foreign trade was carried in American ships of a gross tonnage of 981,000 tons. Forty-nine years later, at the outbreak of the Civil War, the proportion of our foreign commerce carried in American bottoms had decreased to 65.2 per cent., but the tonnage had increased to 2,496,000 tons. Now let us consider the discouraging statement of shipping for the past year. The tonnage in our foreign carrying trade has dwindled to 873,000 tons, we carried but 8.8 per cent. of our foreign commerce, and, moreover, not a single keel for a deep-sea ship has been laid in this country for two years. It is difficult to realize the truth of these facts at a time when other industries are prospering and we are looked upon as the leading producing and manufacturing country of the world. Transportation by sea has, of course, necessarily kept pace with industrial expansion, and the British have been quick to realize the opportunity; their foreign tonnage has now assumed the enormous figure of 14,800,000 tons. Germany comes next with 2,960,000 tons. France and Norway have each about one-half of Germany's tonnage, and Italy's amounts to 1,180,000. The United States is paying annually foreign steamship corporations one hundred millions of dollars for carrying our freight and passengers.

The question immediately raised is, how has this condition of affairs come about? If we once were such great ship builders and owners, why have we relinquished to foreigners our hold on these remunerative industries? While we cannot attempt to answer this complex question, we wish to call attention to a few of the conditions which more or less have had to do with the present state of affairs.

The United States was backward in developing her iron industry, while in England the rich deposits of coal and iron were being mined. As a result Great Britain speedily became the leader of the world in iron products and built up a great fleet of iron ships. This position she has held, increasing in strength year by year; and although we have now taken the lead in volume of iron produced, she far outstrips us in tonnage of vessels afloat. Another reason for our failure to progress in shipbuilding is that the price of ships and the cost of operating them are so much in excess for ships flying the American flag over those of foreign register that capitalists have naturally preferred to invest their money in more remunerative directions. The available work for our coast shipyards has been so small that they have of necessity had to engage in general shipbuilding, and, as a result, cargo ships, yachts, or torpedo boats may be seen building on adjoining stocks, and more or less the same methods of construction used in each. For a yard to build cheaply it is necessary to build one type of boat exclusively. Our ability to turn out cheap boats under such conditions is demonstrated by the Great Lakes shipping, where vessels of 10,000-ton capacity are completed within ninety days of laying the keel and at a very low cost. Again, all foreign countries subsidize their ships to a greater

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or less extent for carrying the mails and for other special privileges granted, and it is against these government-protected vessels that our ships, more expensive to both build and operate, must compete. The handicap to our vessels is most apparent.

Having touched upon the above facts, we call upon our readers for their views as to remedies to be applied, whether by legislation in the form of subsidies, discriminating duties, or free ships, or whether the case lies outside the sphere of legislative action. All must agree, however, that something must be done, and that quickly, in order to save our ships and shipyards. It is a momentous question, one which affects all classes of our great people, whether interested directly or not in maritime affairs.

THE public press has recently contained references to the use of air propellers for marine propulsion. In one case the device seems to have been fitted on a small boat intended for shallow-water navigation on some of the inland waters of France. In the other it was fitted as a means of propulsion for an iceboat which was experimented with on a small lake on Long Island. The latter application is not one which is likely to bring it into serious competition with the usual type of water propeller, and may be here dismissed with the passing notice. In the case of the boat, a water propeller was first fitted, the diameter being about 24 inches and draft of boat but 6 inches. With this equipment a speed of 12 miles per hour is said to have been realized. With this arrangement, in spite of the small draft of the boat, navigation was of course limited to water of sufficient depth to provide for the wheel with its excessive drop below the keel. To remove this limitation the water propeller was removed and an air propeller mounted on deck, carried on a shaft driven by belting from the engine shaft. The air propeller was some 45 inches in diameter, or not quite twice the diameter of the water propeller. With this arrangement a speed of 10 miles per hour is said to have been attained, and the boat was free to navigate anywhere within the limit of its six inches of draft. Looked at from this point of view the exchange seems to have been thoroughly successful in attaining the purpose desired.

Outside the existence of extraordinary circumstances which may, as in the case cited, justify such a type of propelling mechanism, the chief question of interest has reference to the propulsive efficiency of the air propeller as compared with that of the usual type. It may be shown that, due to the low density of air as compared with water, an air propeller, in order to operate under the same general conditions of efficiency as a water propeller, must be some 20 or 25 times greater in size. In the case above cited this would have called for a propeller some 40 feet in diameter, a size quite out of the question, of course, on a small boat some 25 or 30 feet in length. If the size of the air propeller is less than as indicated by this relation, it may be expected that the efficiency will decrease in corresponding proportion. It follows, as a matter of practical construction, that no air propeller can hope to operate under the same general efficiency conditions as a water propeller, simply on account of the excessive size which would be required. In the case cited, where an air propeller of about twice the diameter of the water propeller was employed, we should therefore expect a marked falling off in the propulsive efficiency, and this seems to be shown by the results obtained. At first sight it may seem that a decrease in speed from 12 miles to 10 miles is not very serious, or, from a different point of view, that a speed of 10 miles per hour is very satisfactory for a boat of the size and class in question. Such may indeed be the case; but, viewed purely from the standpoint of propulsive efficiency, we must remember that the power required in such case will vary at least as the cube of the speed, and hence in this case there must have been a loss of efficiency of not less than 40 per cent. That is, the propeller efficiency was presumably somewhere about .40 instead of .68. While in the given case this loss may not have been serious, it is evident that in general such losses could not be accepted, and that any system of propulsion in which losses of this general character are likely to arise can hardly be considered as a serious rival to the accepted system.

Quite independent of the propulsive efficiency of the air propeller, the system presents serious structural problems, and there remains the question of navigation in a head wind. No system of propulsion can be considered satisfactory, of course, which depends on the direction of the wind for its practicability or efficiency, and, except for the purpose of illustrating an important point in propulsive efficiency, the air propeller would hardly merit our serious attention in these columns.

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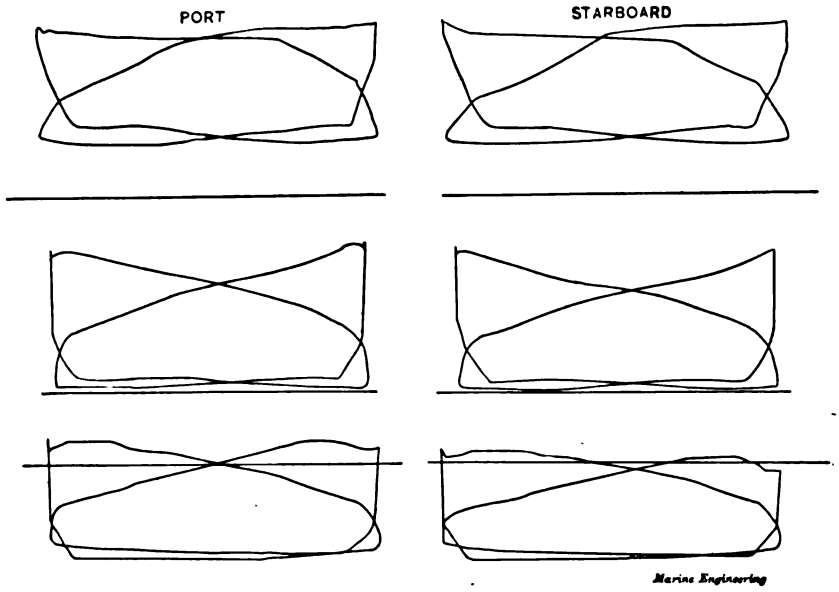
QUERIES AND ANSWERS.

Q. 157.—A triple-expansion engine, when working to full capacity, has the load fairly distributed between the three engines. When under reduced speed the high-pressure engine is linked up and the intermediate and low-pressure engines are left wide open, with the result that the load is no longer equally distributed over the three engines. Say the intermediate and low-pressure engines are linked up until each engine is developing the same power.

(a) Will this have any advantage, other than the wear on the bearings being about the same?

(b) Will the engine be run more economically by linking in the intermediate and low-pressure engines? If so, which would produce the best results, to link the intermediate and low-pressure engines just the same amount the high-pressure engine is linked in, or link them in until the three engines are just balanced?

(c) In twin-screw ships one engine usually drives easier than the other. Which is the best method to run both engines—the same speed, or place the position of the links on the high-pressure engines just the same and allow each engine to make what it will for that particular position of links? J. M.



FIRST SET OF INDICATOR CARDS WITH SAME CUT-OFF.

A.—In the first place, it may be noted that change of cut-off in the high-pressure cylinder does not affect the distribution of the load as much as change in either of the other two cylinders, and not as much as you seem to believe from the way in which the question is put. Change of cut-off in the high-pressure cylinder affects the amount of steam entering the engine, and thus raises or lowers the schedule of pressure all the way through the intermediate and low-pressure cylinders. This will affect the total power developed and to some extent the distribution of load, but not as much relatively as a change in the other cylinders. However, with independent adjustments on each engine, as are now commonly fitted, the intermediate and low-pressure cut-offs may always be so adjusted as to practically equalize the load in the three cylinders, as you assume. The chief advantages of such adjustment are found, as you suggest, in the mechanical operation of the engine. The bearings wear more evenly, the engine usually turns more uniformly, and in addition the conditions for good steam economy are rather better fulfilled with an evenly distributed load. The guide for such an adjustment should be to divide the power, as nearly as may be, equally between the cylinders, or, if there is any variation, it is usually found better to have the least power developed in the high-pressure, next in the intermediate, and the most in the low-pressure. The intermediate-pressure and low-pressure links should therefore be adjusted with reference to the balance of power, rather than with reference to each other or to the high-pressure link.

With twin-screw engines it is usually well to run both engines at as nearly the same speed as can be readily done without any attempt at too refined adjustments. In all practical cases one will run slightly faster than the other with what seems to be the same setting of the links, and if the difference is not great they may be allowed to run in this manner. If the difference seems too great, however, one link may be adjusted until the revolutions are nearly the same on both sides, and the engines may then be allowed to run in that adjustment. There is usually more or less change and irregularity in the revolutions, so that even if the two engines could for a minute or two be brought into perfect step they would not long remain in such condition, but would fluctuate back and forth through a range of variation the extent of which will depend on the circumstances of the case.

DATA FOR FIRST SET.

	Port.	Starboard.
Revolutions	80.5	80.5
Boiler pressure	197 lbs.	197 lbs.
First receiver	67.5 "	60 "
Second "	7.0 "	6.5 "
Vacuum	25 ins.	25 ins.
Cut-off H. P.	29 1-8 "	27 1-4 "
I. P.	29 1-8 "	29 1-8 "
L. P.	29 1-8 "	29 3-8 "
Throttle	Full open.	Full open.
M. E. P.—H. P.	90 lbs.	90 lbs.
I. P.	39 "	38.5 "
L. P	8.88 "	8 25 "
I. H. P.—H. P.	435 6	435.6
I. P.	502.6	490.2
L. P	347.1	322.6
Total	1,285.3	1,254.4

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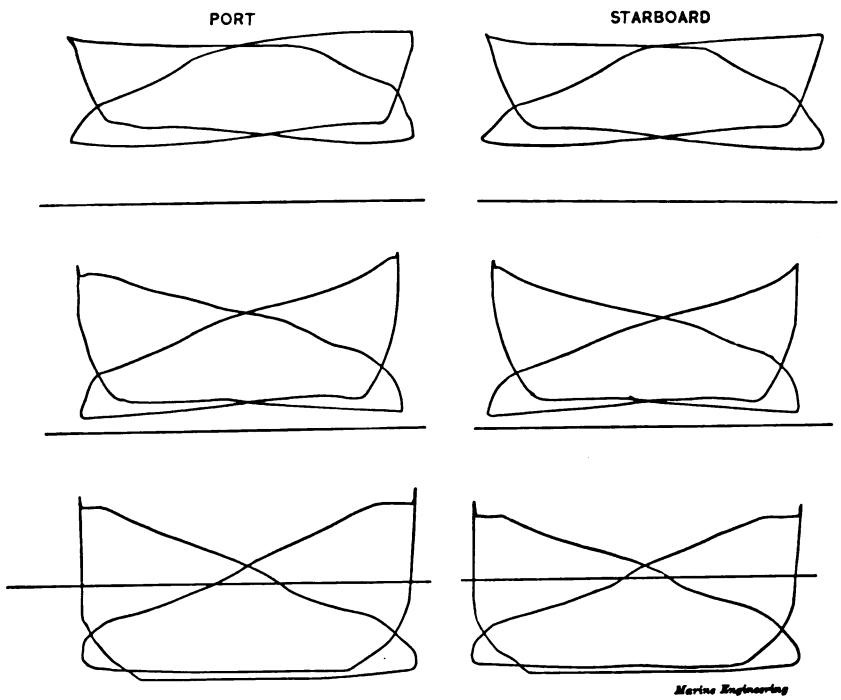
Size of engines	19, 31, and 54 ins. by 42 ins. stroke.
Diameter of rods	5 ins.
Scale of springs	H. P.=100; I. P.=40; L.P.=10 lbs.

DATA FOR SECOND SET.

	Port.	Starboard.
Revolutions	80.16	80.16
Boiler pressure	197 lbs.	197 lbs.
First receiver	77.5 "	68 "
Second "	14.5 "	12 5 "
Vacuum	25 ins.	25 ins.
Cut-off H. P.	29 1-8 "	27 1-4 "
I. P.	27 1-4 "	27 1-4 "
L. P	22 1-8 "	22 1-8 "
Throttle	Full open.	Full open.
M. E. P.—H. P.	78. lbs.	78.5 lbs.
I. P.	35.8 "	33.5 "
L. P	11.5 "	10.8 "
I. H. P.—H. P.	376.0	378.4
I. P	458.8	427 9
L. P	447.8	418.6
Total	1282.6	1224.9



SECOND SET OF INDICATOR CARDS WITH DIFFERENT CUT-OFF FOR DIFFERENT CYLINDERS.

The accompanying cards and data show clearly the effect of linking up in the intermediate and low-pressure cylinders. In general, linking up in the low-pressure will give more work in this cylinder and less in the intermediate-pressure, while linking up in the intermediate-pressure will give more work in this cylinder and less in the high-pressure, and *vice versa* in each case. The adjustment in the second trial might have been made still better by linking up a little more in the low-pressure cylinder and opening out a trifle in the intermediate-pressure. This would have tended to give a still more even distribution of work.

Q. 159.—Will you please tell me how many 16- or 32-candle-power lamps can be placed on a 9-kilowatt dynamo? Also give me rule for determining this. W. H.

A.—On a 9-kilowatt dynamo 117 of 16-candle-power lamps of so-called low economy type may be installed, or 58 of 32-candle-power similar lamps. About 3.4 to 3.8 watts per candle power is the amount of current which should be allowed for this class of lamps, which is the one generally installed, because it is the cheapest. Solving your example with the former figure of 3.4 watts it is as follows:

3.4 x 16 = 76.4 watts per lamp.

9 kilowatts = 9,000 watts. 9,000 ÷ 76.4 = 117.8.

Q. 162.—Will you please advise how to calculate the heating surface of a corrugated furnace flue of the Morison and Fox types?

A.—The heating value of a corrugated furnace has been found to be no greater than that of a plain cylindrical furnace, and in estimating the heating surface of a corrugated furnace the makers consider it the same as for a plain cylinder of diameter equal to mean diameter of the corrugated furnace.

Q. 163.—Will you please advise at what speed a 4 by 3 1-2 single-cylinder engine will drive a propeller wheel 20 inches diameter, the pitch to be best suited for a 26-foot launch; the boiler pressure is 100 pounds and the engine runs non-condensing? T. C. M.

A.—A question such as this, which leaves so much to be assumed, can only be answered in an approximate way. Assuming about 400 revolutions, we find that such an engine should develop somewhere about 6 I. H. P., and should drive a 26-foot launch of ordinary type about 7 miles per hour. Taking a propeller 20 inches diameter and working out a suitable pitch, it is found to be about 25 inches. That is, by solving the problem backward we find that a propeller 20 inches diameter and 25 inches pitch, run at about 400 revolutions per minute, should absorb the 6 I. H. P. with reasonable efficiency and give a speed of somewhere about 7 miles per hour. Such a propeller should have four blades and each blade should have about 32 square inches surface.

Floating Dock.—A large floating dry-dock was successfully launched at Perth Amboy, N. J., on August 1. This dock is owned by the Raritan Dry-Dock Company, the builder, and is 302 feet over all, 92 feet wide, 42 feet deep, with 22 feet of water over keel blocks.

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ENGINEERING SPECIALTIES.

Special Marine Motor.

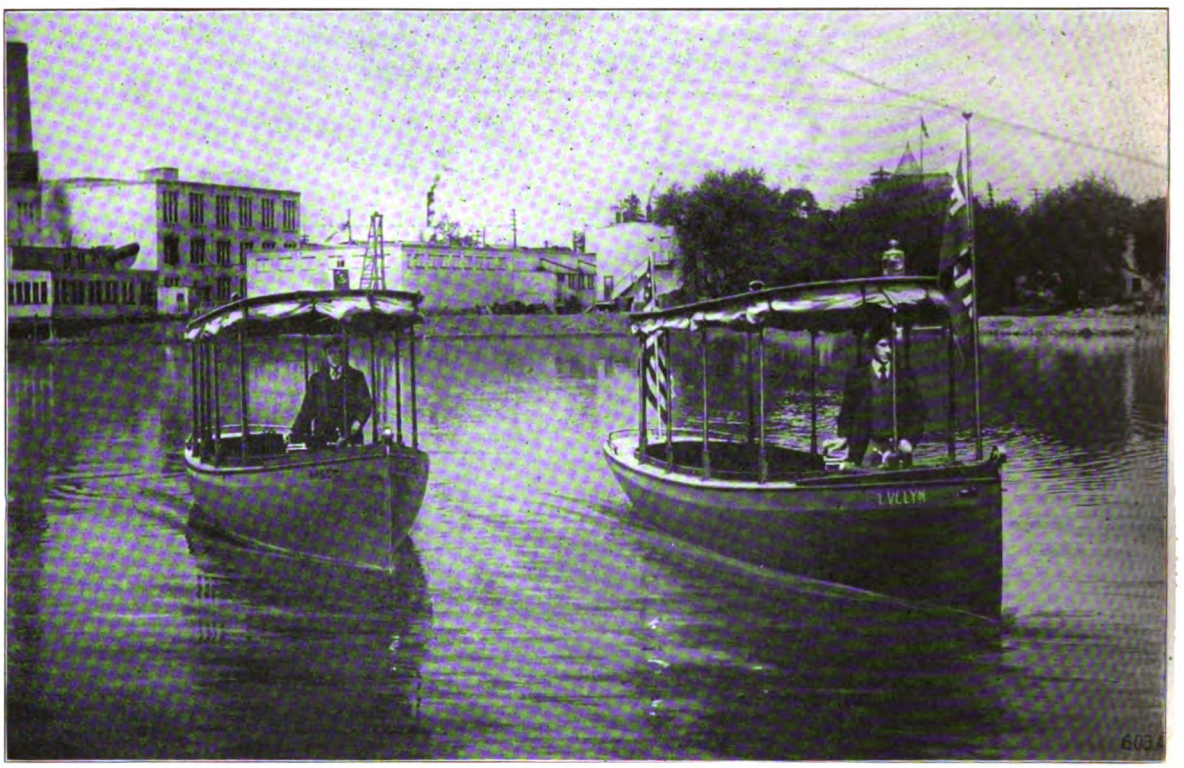
The Northern Electrical Manufacturing Company, Madison, Wis., has evolved a special type of motor which, among other specific purposes, is particularly well suited for the operation of electric launches. It is readily adapted to the frame and equipment of a modern launch, and, having a very low center of gravity, can be placed on the keel; adding to the safety and stability of the boat, as well as projecting but little into the cockpit.

The field frame of this motor is cast with a circumferential ring, which is machined in accurate alignment with the armature shaft. The bearings are mounted in patented bonnets, and lubricate the shaft by the oil-ring method, ample storage capacity being provided for oil.

The construction of the bearings is such that the motor may be applied at any angle, varying from horizontal to the position necessitated by the inclination of the propeller shaft. When built as a marine motor the Northern universal type motor armature shaft terminates in a disk which forms one half of the coupling with the propeller shaft. A similar disk is mounted on the propeller shaft, and the two bolted together.

These motors are built in sizes ranging from 2 to 40 horse power, to operate at speeds specified by the purchaser. The electrical construction of the motor is such as to secure great economy in the consumption of current and not entail severe drains on the storage batteries by losses in the motor.

The motor may be secured to the boat frames by means of legs bolted to the motor field and the current frames, or by means of a circular split bracket with provision for securing the motor in place, the bracket to be bolted to the boat frames. The illustration accompanying shows electric launches equipped with Northern motors. The steering and controlling mechanisms in this boat are located in the bow, and the motor controller occupies practically no room required for passengers. The controller may be placed at whatever point in the launch is most convenient.



ELECTRIC LAUNCHES EQUIPPED WITH NORTHERN ELECTRIC MOTORS.

Vertical Marine Type Engine.

To meet the requirements of continued hard service, the American Blower Company, Detroit, Mich., has especially designed an open-frame extra heavy engine, which is illustrated in the cut on opposite page.

The base is a solid casting, dished to receive the drippings of oil and water from the engine. The main bearings are made large, and lined with the best quality of anti-friction metal, and provided with ring oilers. The lower halves of these bearings are cast solid in the base, with chambers to hold the oil. The back frame is of cast iron, to which are attached the crosshead guides, and the top forms the base of the cylinder casting. The front columns are of steel, the tops setting in lugs on the back frame.

The cylinder and steam chest are in one casting securely bolted to the frame. A double-ported balance piston valve properly designed is fitted, and the steam ports are ample and allow a thorough drainage. Eccentric and strap are of cast-iron, and the rod is of cast-steel provided with adjustment for taking up wear. The piston is a hollow disk fitted with snap packing rings. The crank shaft and connecting rod are of cast-steel, the latter having forked crank ends, and both ends are provided with means for taking up wear. This adjustment

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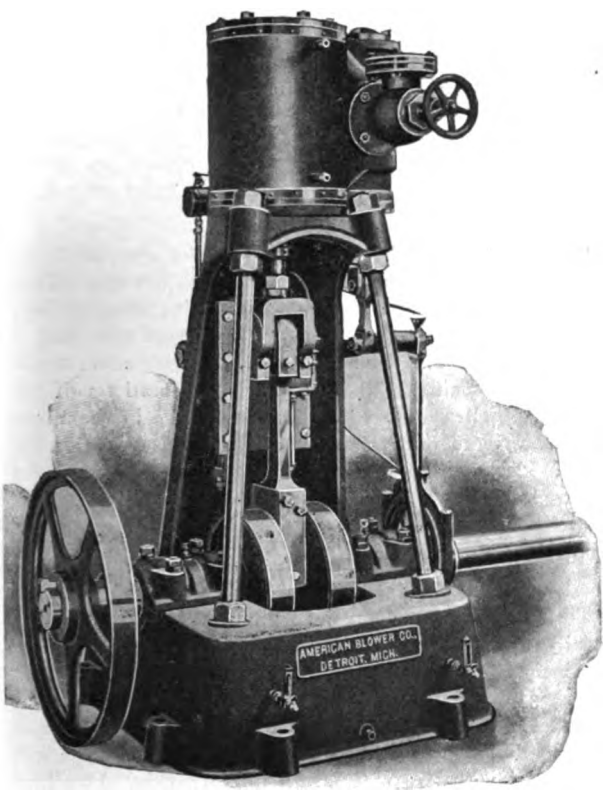
is accomplished by taper keys moved by screws and secured in position by lock nuts. The crosshead is a solid casting and is of the slipper type. As above mentioned, the guide is cast to the engine frame, but the front guides are of forged-steel, securely bolted to the frame of the engine.

The engine is fitted with a sight-feed lubricator, and all the moving parts, with the exception of the main bearings, piston, and valve, are lubricated by a single oiling device. The engine is also fitted with throttle valve, cocks, Rites' governor, and hand wheel.

Two of these engines were included in the steamer *Sprague* outfit.



VERTICAL ENGINE FOR HEAVY SERVICE.

Marine Engine Governor.

The engraving shows the essential features of a new marine engine governor patented and made by M. F. Volkmann, Santa Monica, Cal., which it is claimed will act under all conditions. It consists of a centrifugal governor, whose driving shaft is constructed for two speeds, receiving power from a main driving shaft by sprocket wheel and chain connection. The main driving shaft is driven from the crank shaft by gearing and shafting, and carries a loosely-mounted sprocket wheel, larger than the others, having the hub extended on each side, and connected by chain to the governor shaft. Two power-controlled friction clutches are mounted on the shaft to engage the hub of the loosely mounted wheel; the action of one is controlled by a pendulum and valve, the other by a float-controlled valve, to which it is connected bv piping, the float being placed in a well near the propeller.

In order that a governor work successfully on a marine engine it is necessary that it should anticipate an increase in engine speed due to the propeller coming out of the water. In the Volkmann governor this is accomplished by means of the pendulum-controlled valve that allows a clutch to change the governor speed when the stern of the ship is about to rise. A simple device, not shown in the engraving, that controls a piston and rod, is employed to move the pendulum rearward when the stern of the ship begins to descend, thus releasing the pendulum-controlled clutch and preventing unnecessary loss of speed. The float-controlled valve at the stern allows the governor speed to be changed at any time when the propeller is not sufficiently immersed, and will prevent the engines racing if the propeller is not sufficiently immersed when the pendulum-controlled clutch is released. As the governor is driven by the engine, it is impossible for them to race beyond a safe speed should an accident occur to the propeller or to the shaft.

A MARINE ENGINE GOVERNOR.

A New Direct-Connected Set.

A small direct-connected engine-generator set for marine purposes, possessing many qualities that will appeal to those concerned with the design and equipment of small steam vessels, is illustrated on the following page. It presents the association of a Crocker-Wheeler multipolar open-type generator and a Forbes simple upright engine, each a standard piece of apparatus, with only such changes made in details as were necessary to bring them into perfect harmony of operation.

Of primary importance among its commendable features are the lightness and compactness of the outfit. Although it has a capacity of 8 kilowatts, or sufficient to light upward of 140 16-candle-power lamps, it weighs but 2,800 pounds, and in extreme dimensions measures only 52 5-8 inches long, 35 1-4 inches wide, and 51 3-4 inches high. The engine has a 7-inch cylinder, a 6-inch stroke, and with a steam pressure of 100 pounds develops 20 indicated horse power at 425 revolutions per

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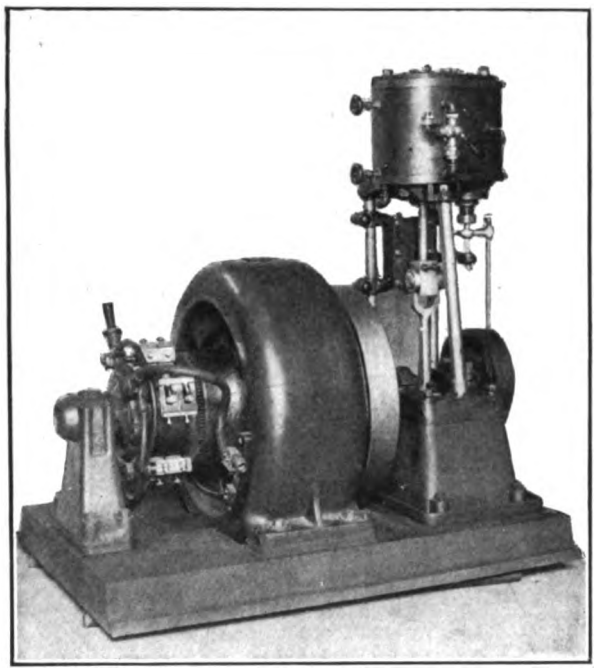
minute. By itself the engine weighs but 475 pounds, principally possible due to its very light and simple tripod-frame construction, the legs of which are of steel, so that it possesses all of the desirable characteristics of rigidity and safety. A cylindrical type of valve is employed, and the speed regulation is afforded by a Rites form of inertia governor guaranteed not to allow a variation of more than 2 1-2 per cent. from constant speed. The governor is entirely distinct from the flywheel, the latter being placed between the engine and the generator, covering the coupling, while the former is self-contained and located on the opposite end of the shaft. The crosshead and piston rod are in one piece; all forgings are of the best open-hearth steel without welds, and the crank shaft is machined from a solid forging. The oiling can be accomplished while the engine is in motion; equipment, though not so shown



HIGH-SPEED, DIRECT-CONNECTED GENERATING SET.

in the cut, consisting of a gravity lubricating system composed of a number of small pipes leading from an elevated reservoir to all the wearing parts.

In service of this class the need of an enclosed type of dynamo is not felt. Almost invariably a location may be selected where dust and inflammable materials are not present, and where the slight protection required is readily procurable. Being of open construction, this generator has special advantages, such as accessibility of its parts for instant inspection or attention of any sort, and the best possible ventilation for the armature and windings, thereby keeping the heating down to desirably low limits even under a high per cent. of overload.

The engine builder is W. D. Forbes Company, Hoboken, N. J., and the Crocker-Wheeler Company, electrical engineers and manufacturers, of Ampere, N. J., supplies the dynamo.

LAUNCHES.

Fireboat Hewitt.—The fireboat *Abram S. Hewitt*, built for the City of New York, was launched on July 11 from the yard of the New York Shipbuilding Company, Camden, N. J. The *Hewitt* is one of the swiftest and most powerful fireboats built. Her principal dimensions are: length, 110 feet; beam, 24 feet, with a speed of 10 knots an hour. This boat was described in MARINE ENGINEERING for March, 1903.

Steamer Saxonia.—On Saturday, June 6, there was launched from the old Globe yard, Cleveland, the steamer *Saxonia*, the last of three 6,200-ton steamers being built by the American Shipbuilding Company for G. A. Tomlinson, of Duluth. The principal dimensions of the *Saxonia* are: length over all, 436 feet; length over keel, 416 feet; beam, 50 feet; depth, 28 feet. She will have triple-expansion engines with cylinders 20, 33 1-3, and 55 inches diameter and 40 inches stroke, supplied with steam from two Scotch boilers 13 feet 2 inches in diameter and 11 1-2 feet long, fitted with Ellis and Eaves draft.

Steamer C. W. Morse.—On July 11 the steamer *C. W. Morse* was successfully launched at Wilmington, Del., for the People's Evening Line for service between New York and Albany. This vessel is built of steel and is 430 feet over all. She has three full state-room decks above the main deck. The interior decorations of the saloons, galleries, and state rooms will be in the Louis XVI. style, in white and gold. The dining room on the main deck will seat 300 persons. The boat has been towed to New York to the yards of the A. and F. Fletcher Company, Jersey City, where her engines and joinery will be fitted.

Turkish Cruiser Medjidie.—The *Medjidie*, the first Turkish cruiser built in the United States, was successfully launched at Cramps' shipyard on July 25. The principal dimensions of this vessel are: length on water line, 330 feet; beam, extreme, 42 feet; draft, mean, 16 feet. Her displacement will be about 3,250 tons and she is designed to indicate 12,000 horse power. She will be fitted with two masts with military tops. Her battery will comprise two 6-inch guns mounted fore and aft on the center line, eight 4.7-inch guns mounted broadside, and six 3-pounders and six 1-pounder rapid-fire guns. The *Medjidie* has been constructed for a speed of 22 knots an hour and will be fitted with modern triple-expansion engines and improved water-tube boilers.

Battleship King Edward VII.—On July 25 the new British battleship *King Edward VII.* was successfully launched at Devonport. The *King Edward VII.* is stated to be the largest battleship in the world, being 350 tons more than the *Louisiana*, building at Newport News, and the *Connecticut*, now building in New York. Her principal dimensions are: length, 425 feet; beam, 78 feet; draft, 26 3-4 feet. The engines are designed to indicate about 18,000 horse power. The armament of the *King Edward VII.* consists of four 12-inch guns, four 9.2-inch guns, ten 6-inch guns, and twenty-four guns of smaller caliber. Her estimated speed is 18.5 knots and she carries 950 tons of coal and has a complement of 800 men.

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Steamer Captain W. Menzell.—The steamer *Captain W. Menzell* was launched from the yard of the Flensburg Shipbuilding Company, Flensburg, Germany, on July 14. The vessel is 301 feet long, 41 feet broad, and 21 feet 3 inches deep. She will have a carrying capacity of 3,550 tons, and is built to the requirements of the German Lloyd's for the Hanseatic Dampfer Compagnie, Hamburg, which firm will use her for its trade with China.

German Steamship.—On March 5 the Flensburger Schiffbau Gesellschaft, Flensburg, Germany, launched from its yard the steel screw passenger and cargo steamer *Prinz Joachim*. The principal dimensions are as follows: length over all, 385 feet; between perpendiculars, 370 feet; breadth, extreme, 45 feet 3 inches. The *Prinz Joachim* is built for the Hamburg-American Line and is a sister ship to one built for the same firm in November last. She is constructed of best Siemens-Martin steel, according to the requirements of the German Lloyd's and Seeberufsgenossenschaft, having long poop, short forecastle, and steel decks running the whole length of the ship, also eight extra water-tight bulkheads. The vessel is propelled by engines of the direct-acting, quadruple-expansion type, of 3,000 I.H.P., with cylinders 23 1-4, 33 1-4, and 49 1-4 inches and 54 inches stroke, giving her a speed of 13 1-2 knots. Steam is supplied from three single-end boilers, 14 feet 11 inches by 12 feet 1 inch long, provided with forced draft. The christening ceremony was performed by Fräulein Henny Bauer, daughter of Director Bauer, of the Flensburg Company.

PERSONALS.

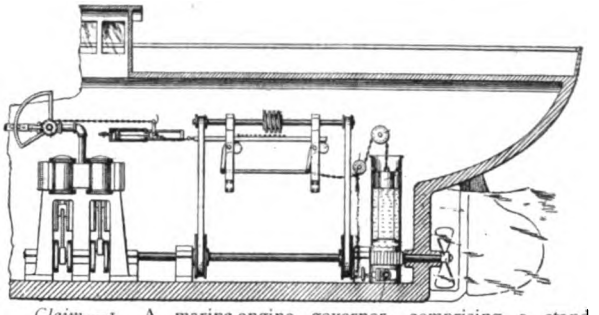
Edwin E. Mager has left the construction and repair department of the Brooklyn Navy Yard to accept a position in the hull department of the New York Shipbuilding Company.

Harry Fromm, marine engine draftsman, has severed connections with the Crescent Shipyard Company and is now in the drafting department of the Townsend-Downey Shipbuilding Company.

Captain George M. Walker, late of the Old Dominion Line, died at his residence in Brooklyn on July 31, aged 77. On his retirement from active life he was the oldest captain sailing out of the port of New York. He was born at sea in July, 1826, his father being captain of the British brig *Fox*. In his early career he sailed in the *Humboldt*, then on the *Washington*, the *Franklin*, and the *Arego*. He then became captain of the *Fulton*, and carried stores to Port Royal during the Civil War. He captured the blockade runner *Margaret and Jessie*, and later another blockade runner, the *Banshee*, off Wilmington, Del. Later Captain Walker commanded the *Raleigh*, *Niagara*, *Albemarle*, and innumerable other well-known steamers. While on the *Albemarle* he received a gold medal for rescuing the crew of a wrecked schooner. He led an exceedingly active life, and retained to the very last years of his seafaring life his mental and physical faculties. He was held in high esteem by all the officers of the Old Dominion Steamship Company, with whom he was connected for so many years, and was respected by all who came in contact with him.

SELECTED MARINE PATENTS.

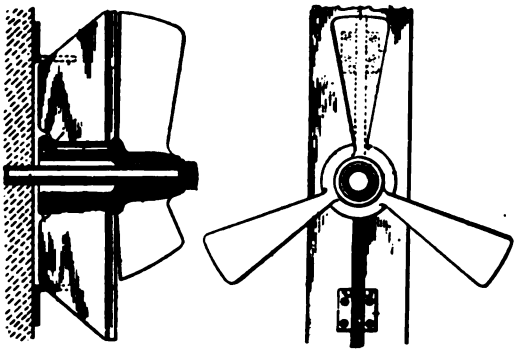
732,567. MARINE-ENGINE GOVERNOR. GEORGE F. LASHER, PORTLAND, OREGON, ASSIGNOR OF ONE-HALF TO ISAAC B. HOLZMAN, PORTLAND, OREGON.



Claim.—1. A marine-engine governor, comprising a stand pipe in the vessel, a float working in the stand pipe, a driven gear, a gear normally disengaged from the first-named gear and capable of meshing therewith, means for moving the second gear into mesh with the first-named gear and actuated from the said float, and a connection between the second-named gear and the engine.

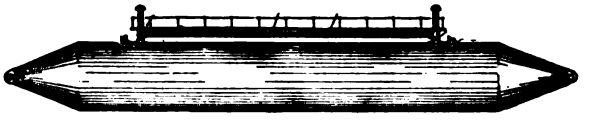
2. A marine-engine governor, comprising a stand pipe in the vessel, a float working in the stand pipe, a driven member, a second member normally disengaged from the said driven member and movable into engagement therewith, cams actuated from the float for moving the second member into engagement with the driven member, and a connection between the second-named member and the engine. Ten claims.

732,568. SELF-CLEARING PROPELLER. CHARLES H. LEE, SOUTHAMPTON, N. Y.



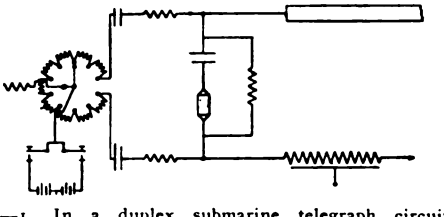
Claim.—2. The combination with a screw propeller, of a non-revoluble clearing device carried directly by a part revoluble with said propeller, located forward of the latter, and occupying a predetermined invariable relation to the blades thereof. Fifteen claims.

732,920. SUBMARINE BOAT. FRANK T. CABLE, NEW SUFFOLK, N. Y., ASSIGNOR TO ELECTRIC BOAT COMPANY, A CORPORATION OF NEW JERSEY.



Claim.—1. The combination with a boat, of a tube in the same containing a slidable piston weight, a fluid in said tube and filling the same, and means for shifting said fluid from one side of said weight to the other proportionately for shifting the position of the weight along the tube. Three claims.

733,556. SUBMARINE TELEGRAPHY. ALEXANDER MUIRHEAD, SHORTLANDS, ENGLAND.



Claim.—1. In a duplex submarine telegraph circuit, the combination of a transmitter and its battery, sending and receiving condensers, a rheostat, a receiver, self-inductances serving to regulate the amount of "curb" required to produce the most rapid changes at the beginning of the cable, further self-in-

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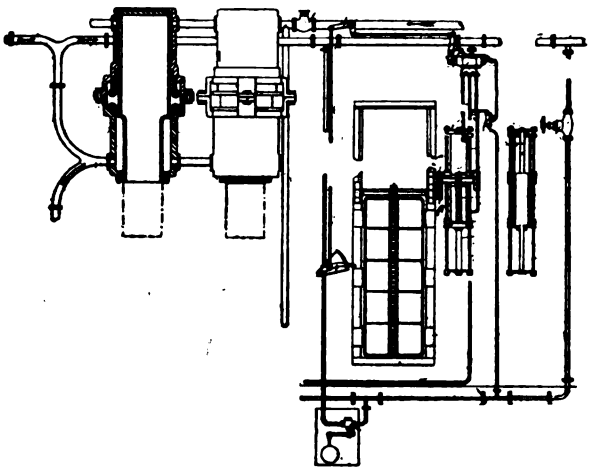
ductance serving as a shunt to the said receiver and its condenser through which the steady current passes while current impulses or rapid variations of potential operate such receiver, and other self-inductances serving to facilitate the final duplex balancing. Four claims.

733,583. FREIGHT BARGE. LEWIS P. HARVEY, OAKLAND, CAL., ASSIGNOR OF THREE-FOURTHS TO WILLIAM LEACH AND EDWARD S. HOUGH, OAKLAND, CAL., AND JAMES DICKIE, SAN FRANCISCO, CAL.

Claim.—1. A barge having a cylindrical body portion with conical ends, air chambers formed in the conical ends, and means connecting the conical ends inside the body portion.

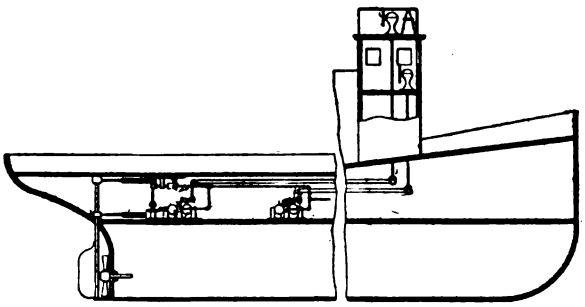
3. A barge having a cylindrical body portion with conical ends, bulkheads separating the body portion from the conical ends and forming air chambers, and a longitudinal partition connecting said bulkheads, said partition extending from the keelson to the top in the center but tapering at its ends to admit a flow of the cargo. Five claims.

733,745. MECHANISM FOR OPERATING BULKHEAD OR OTHER DOORS. GAVIN C. RALSTON, LONDON, ENGLAND, ASSIGNOR TO J. STONE AND COMPANY, DEPTFORD, ENGLAND.



Claim.—1. In a bulkhead door operating installation consisting of a pump, a hydraulic accumulator, cylinders supplied with water pressure therefrom, connections between the cylinder pistons and the doors for operating the latter, valve devices (the emergency valve) for distributing said pressure to the cylinder pistons, and a valve operated from the bridge, in the engine room, or other part of the ship for effecting the simultaneous closing and opening of all the doors, a pipe connection between the accumulator and the steam boiler, a handle at each door and connections between the same and the said emergency valve whereby, after the doors have been closed by the aforesaid valve from the bridge, any men enclosed behind the closed bulkhead doors can, by operating the aforesaid handle, again open communication between the partly-exhausted accumulator and the door cylinder so as to open said door, the steam from the boiler following up the receding ram and water in the accumulator, and whereby when the men have escaped and let go the handle the door closes of itself again.

733,893. STEERING GEAR FOR BOATS. EARL C. AKERS, PORT HURON, MICH., ASSIGNOR TO WILLIS A. PAGE, CHICAGO, ILL.



Claim.—1. The combination with a main steering gear of a boat, embracing a rudder post, of an auxiliary steering gear comprising, in combination with a quadrant fixed to said post, a spare steering wheel, a rotative shaft, means whereby said shaft is rotated through power applied to the spare steering wheel, and clutch elements on said auxiliary quadrant and shaft which are normally out of engagement, and means for moving such clutch elements into engagement.

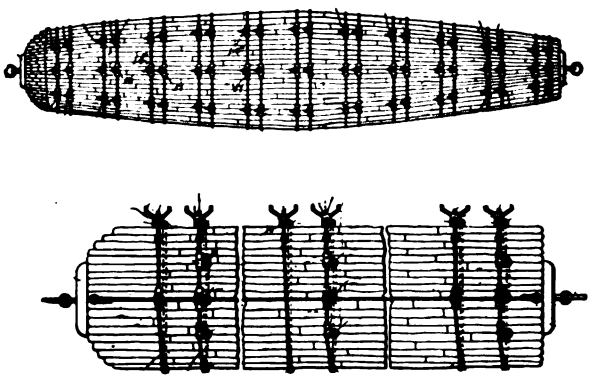
2. The combination with the main steering gear of a boat, embracing a rudder post, of an auxiliary steering gear comprising an auxiliary quadrant fixed to said rudder post, a spare steering wheel, a rotative shaft, means whereby said shaft is rotated by power applied to the spare steering wheel, a clutch collar on said shaft which is normally out of engagement with said auxiliary quadrant, and means for moving said collar into engagement with a friction surface on the auxiliary quadrant. Six claims.

733,910. ART OF DETERMINING THE NAUTICAL BEARING OF NAVIGABLE VESSELS. HERMON W. LADD, BOSTON, MASS., ASSIGNOR TO GEORGE E. SMITH, TRUSTEE, EVERETT, MASS.

Claim.—1. The method of determining the direction of motion of Herzian signal waves, which consists in shielding an elevated conductor of a wireless telegraph receiving station from said waves on certain sides and exposing it to waves on one side, and in rotating the shielding element until the receiving conductor is exposed to said waves.

2. The method of receiving Herzian signal waves from any one of a number of signaling stations, to the exclusion of similar waves from other stations, which consists in shielding the elevated conductor of a wireless telegraph receiving station from such waves in certain directions, and exposing it in the direction from which the desired signal waves emanate.

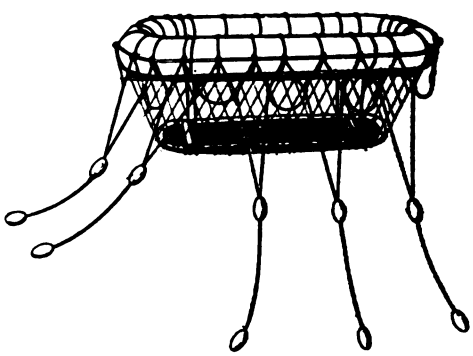
734,050. RAFT. JOSEPH G. ELDERKIN, FOX RIVER, CANADA.



Claim.—1. A timber raft made up of separate sections extending to the sides of the raft, section-binder cables surrounding each section and raft-binder cables surrounding all the sections and crossing the outer sides thereof, binding said sections together.

2. A timber raft made up of separate superposed sections extending from side to side of the raft, section-binder cables surrounding each section, and raft-binder cables surrounding all the sections and crossing the outer sides thereof. Five claims.

734,118. LIFERAFT. HORACE S. CARLEY, HYDE PARK, MASS., ASSIGNOR TO CARLEY LIFEFLOAT COMPANY, PHILADELPHIA, PA., A CORPORATION OF WEST VIRGINIA.



Claim.—1. In a collapsible reversible liferaft, a buoyant body of annular or similar continuous form, a bottom, a flexible part secured at one edge around the edge of the bottom, rings or eyelets arranged at suitable intervals along the other edge of said flexible part, flexible rings around the buoyant body passing through the eyelets on the flexible part, and draw ropes extending longitudinally along the buoyant body attached to the flexible rings and drawing the same tightly against the outer surface of said body but leaving them loose at the inner surface thereof, so that the eyelets or rings on the flexible part can run freely on the flexible rings. Four claims.

732,082. APPARATUS FOR CLEANING SHIPS' BOTTOMS. CHARLES JOHNSON, ST. GEORGE, CANADA.

Claim.—1. An apparatus for cleaning ships' bottoms, comprising a movable frame, rotary devices carried thereby for cleaning the bottom, a differential chain hoist adapted to be attached to the side of the vessel, a pulley mounted on the movable frame over which the chain of said hoist passes, a shaft on which said pulley is mounted, and means operatively connecting said pulley with said rotary cleaning devices. Five claims.

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Marine Engineering

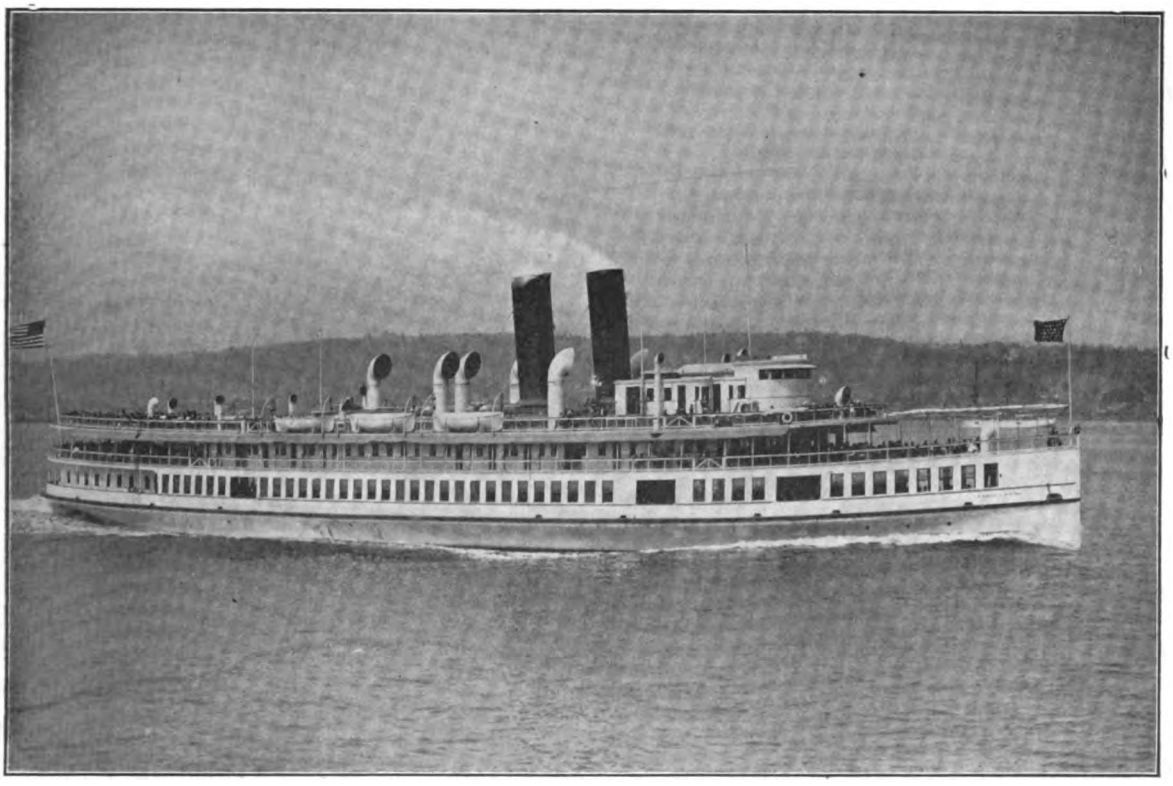
Vol. VIII. NEW YORK, OCTOBER, 1903. No. 10.

NEW STEAMER ASBURY PARK, FOR THE NEW YORK-SANDY HOOK ROUTE.

For fifteen years all new yachts sailing in or around the harbor of New York, which claim any great amount of speed, have invariably attempted to establish their reputation in this line by racing with either the *Monmouth* or *Sandy Hook*, plying between New York and Atlantic Highlands, in the service of the Central Railroad of New Jersey.

Although these vessels came out so many years ago, it is but few yachts or Long Island sound steamers that can hold their own against them. The course from the New York pier to the one at Atlantic Highlands is 18 nautical miles, down through New York bay, the Narrows, and across the lower bay, the last 3 miles being through shoal water across the Flats; yet the distance is covered by these two boats in about the average of one hour five minutes. Speed and regularity are the two most essential requirements of this service. The vessels run on the schedule as exact as a railroad train.

To meet the increased travel over this line to and from the Jersey coast resorts, last year the owners contracted with the William Cramp and Sons Ship and Engine Building Company, the builders of the *Monmouth*, for a new steamer, about 300 feet long, to draw not more than 11 feet, and on trial of 4 hours to maintain an average speed of 20 knots. The first keel plate was laid September 13, 1902, and the first frame raised October 23, 1902. On March 28, 1903, a very successful launch was made and the vessel was christened the *Asbury Park*. After the launch the boilers and engines were at once installed and the work pushed vigorously toward completion, and on June 5, 1903, the vessel was finished and left the yard for New York for delivery to owners.



FAST TWIN-SCREW STEAMER ASBURY PARK, FOR THE NEW YORK-SANDY HOOK ROUTE.
[Photographed especially for Marine Engineering by E. Muller.]

The *Asbury Park*, like her running mates, is devoted entirely to passengers, no cargo being carried. The general arrangement is shown on pages 496 and 497, which gives deck plans and longitudinal section.

In the forward hold is the chain locker, a large peak tank after the collision bulkhead; then follow two large compartments for stores, the forward one

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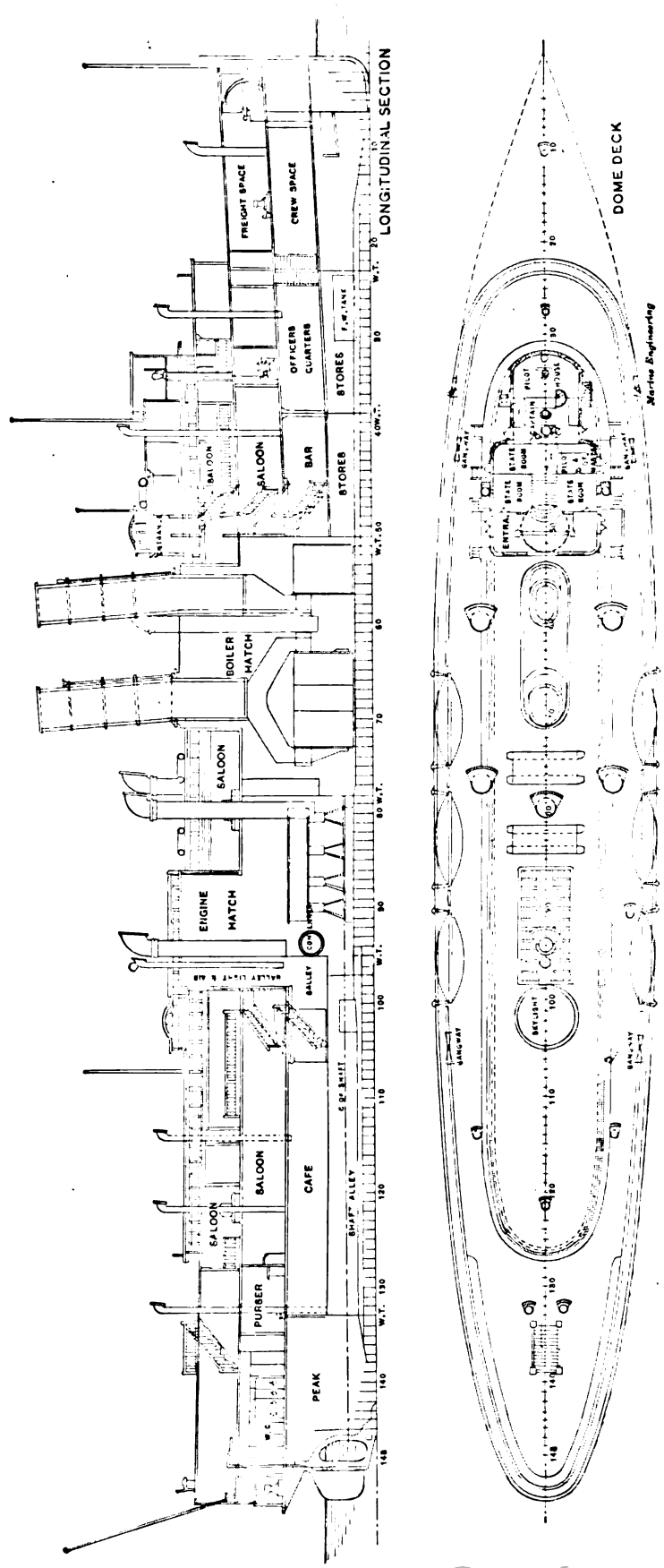
containing fresh-water tank. On lower deck forward, aft the collision bulkhead, is the forecastle with berths for 9 deck hands and 15 firemen. It is entered from companionway on the main deck, and is fitted with wash room and closets. In the next water-tight compartment are the engineers' and officers' quarters; on the port side are state rooms for 5 porters, 4 watchmen, and 2 mates, while on the starboard side are two rooms for the oilers and a room for the first and second assistant engineers. The next water-tight compartment is devoted entirely to the bar room, entered by winding stairs from the main deck.

The boilers and coal bunkers occupy the full breadth of the ship for a distance of 54 feet, the coal bunkers being arranged on either side of the ship. In the next compartment are the two sets of three-cylinder, quadruple-expansion engines and all auxiliary machinery. Following aft is the steward's department, which consists of a galley, placed amidships, crew's mess room and officers' mess room and stores on the port side, and pantry, refrigerators, and store room on the starboard side. Two state rooms for the cooks are directly aft of store rooms on either side. The café, or dining saloon for passengers, occupies the space aft of the collision bulkhead, entered by stairs from the main deck. On the center line in the shaft alley is placed a fresh-water tank.

The anchor and windlass are placed on the main deck, a davit being fitted forward to swing anchor overboard through large side ports. The steam-steering engine is placed just forward of a screen bulkhead. The stair-case just forward of the boiler casing leads from the deck to the main saloon above. Abreast of the engine room are the chief engineer's room and two state rooms on the starboard side and a firemen's lobby and two state rooms on the port side. A large ventilator is arranged just aft of the engine hatch for carrying light and air to the galley, and on the port side is a stairway leading from the deck down to the galley and mess rooms. The quarter deck is spacious, laid with rubber interlocking tiles. One state room and a news stand are aft of the gangways. At the after end are the



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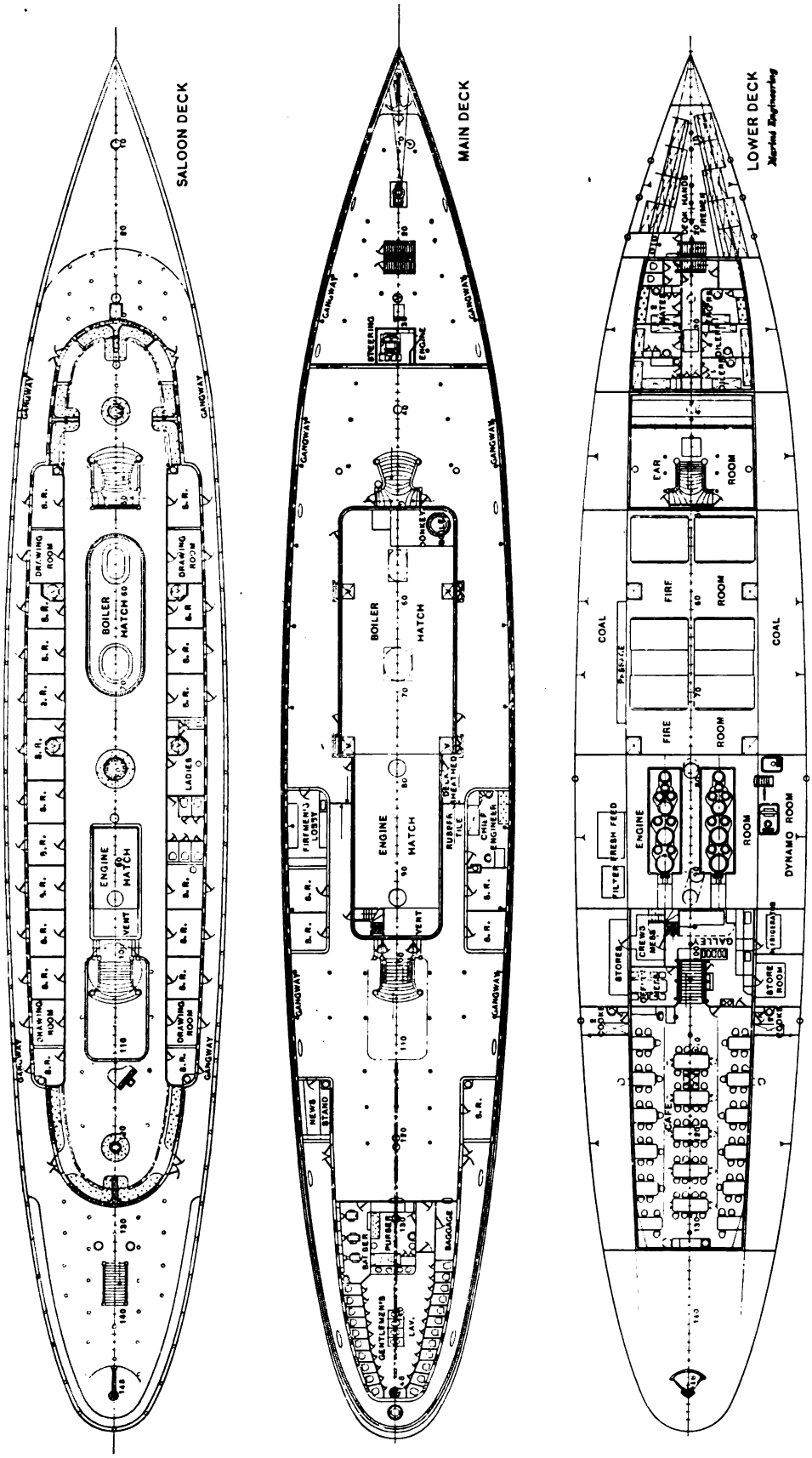

LONGITUDINAL AND DECK PLANS OF THE NEW STEAMER ASBURY PARK, OWNED BY THE CENTRAL RAILROAD OF NEW JERSEY.

purser's office, barber shop, and a passage leading to the toilet rooms. The main stairway leads to the saloon on the deck above. Doors open out to a narrow deck for convenience in handling the line, and at the after end is the steam capstan. The joinery for this deck is in quartered oak.

There is a large house on the saloon deck, about 195 feet long. The forward end has large plate-glass windows at the front and side and is fitted with comfortable divans. Continuing aft on either side are 19 large state rooms, 4 drawing rooms, and a ladies' boudoir. The joinery of this deck is in quartered oak, and abundant light

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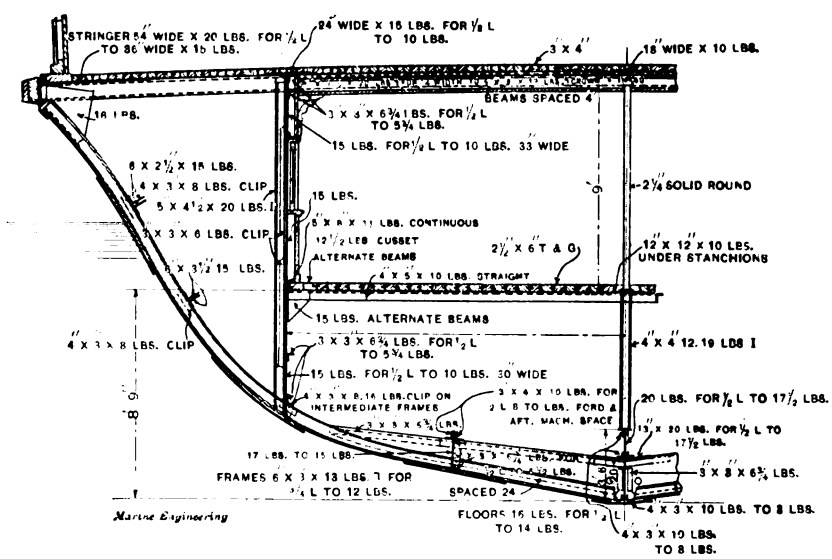
is admitted through side lights above the state rooms and through a large dome aft. The after end of cabin is fitted up similarly to the forward end. The deck is covered with Wilton carpets of olive tint, and the general color of furnishings is also in olive.

A large deck space is provided both forward and aft, the line of dome deck forward extending from well forward of the house to the stern. Gangways are placed on both sides at the forward and after quarters. The dome deck gives large open passenger space, while at the forward end are the pilot house, captain's room, pilot and quartermaster's room, and three state rooms. This deck is reached from the saloon by forward staircase landing in the entrance hall, and at the after end by a companionway which leads from the open saloon deck. Six lifeboats swing on davits and three liferafts are provided. A large skylight is fitted over the engine hatch and galley ventilator, and another is placed over the main stairway, as mentioned above. Four large ventilators carry air to the boiler room, two to the engine room, one to the galley, and several others are fitted to supply fresh air.

HULL.

The construction of this boat embraces several interesting features. In the first place, to build a boat of this size, and give her enough engine power to drive her at 20 knots speed at a draft of not over 11 feet, requires that weights be cut down and the hull lightened wherever possible without interfering with strength. From the sections of the *Asbury Park* given herewith the scantlings of members will be found. It will be noticed that the molded depth is about 17 feet; to provide for longitudinal strength for this shallow hull, two fore-and-aft bulkheads are fitted in the way of boiler and engine rooms, and the strength carried to the ends by lattice girders, as shown in section. These two bulkheads and girders extend from the bottom to the main deck from end to end of the vessel. The form of the frames shown in the sections should be especially noticed: instead of rising with maximum beam at the water line, they flare out and are given a reverse curve which carries them out to the guard; thus the increased beam of passenger steamboats is secured without exposing the counter to the force of the sea, the vessel is made stiff against rolling due to the increased buoyancy, and this space is available for coal bunkers or for store rooms.

The hull is divided into seven compartments by six water-tight bulkheads. Frame No. 5 is the forward collision bulkhead; forward holds with chain locker extend as far as frame 23; at this point and also at frame 38 are water-tight bulkheads. No. 50 forms forward boiler-room bulkhead, No. 78 is forward engine-room bulkhead in which is placed a water-tight door, and frame No. 95 is after engine-room bulkhead, recessed at bottom for thrust bearings, fitted with water-tight door leading into the shaft alley; and at frame No. 133 are the stern-tube bulkheads, or really deep frames for the two shafts. Each of these two bulkheads extends from the side of the ship to a point about 4 feet from the center line to carry the stern tubes. The after collision bulkhead is at frame No. 145. Web frames are fitted one in each forward compartment, two in the boiler room, one in engine room, and two in after hold, to provide for special stiffness.



SECTION FOR'WD & AFT OF MACHINERY SPACE.

SECTIONS OF THE NEW STEAMER ASBURY PARK, BUILT

MACHINERY.

Two views of one set of the engines of this fast boat are given on pages 500 and 501. There are two sets of four-cylinder, triple-expansion engines, the diameters of the cylinders being 23, 37½, 43, and 43 inches by a common stroke of 30 inches. Piston valves are fitted throughout, one on the high-pressure cylinder and two on each of the other cylinders. The high- and intermediate-pressure cylinders, with pistons between, are made in one casting, and the two low-pressure cylinders,

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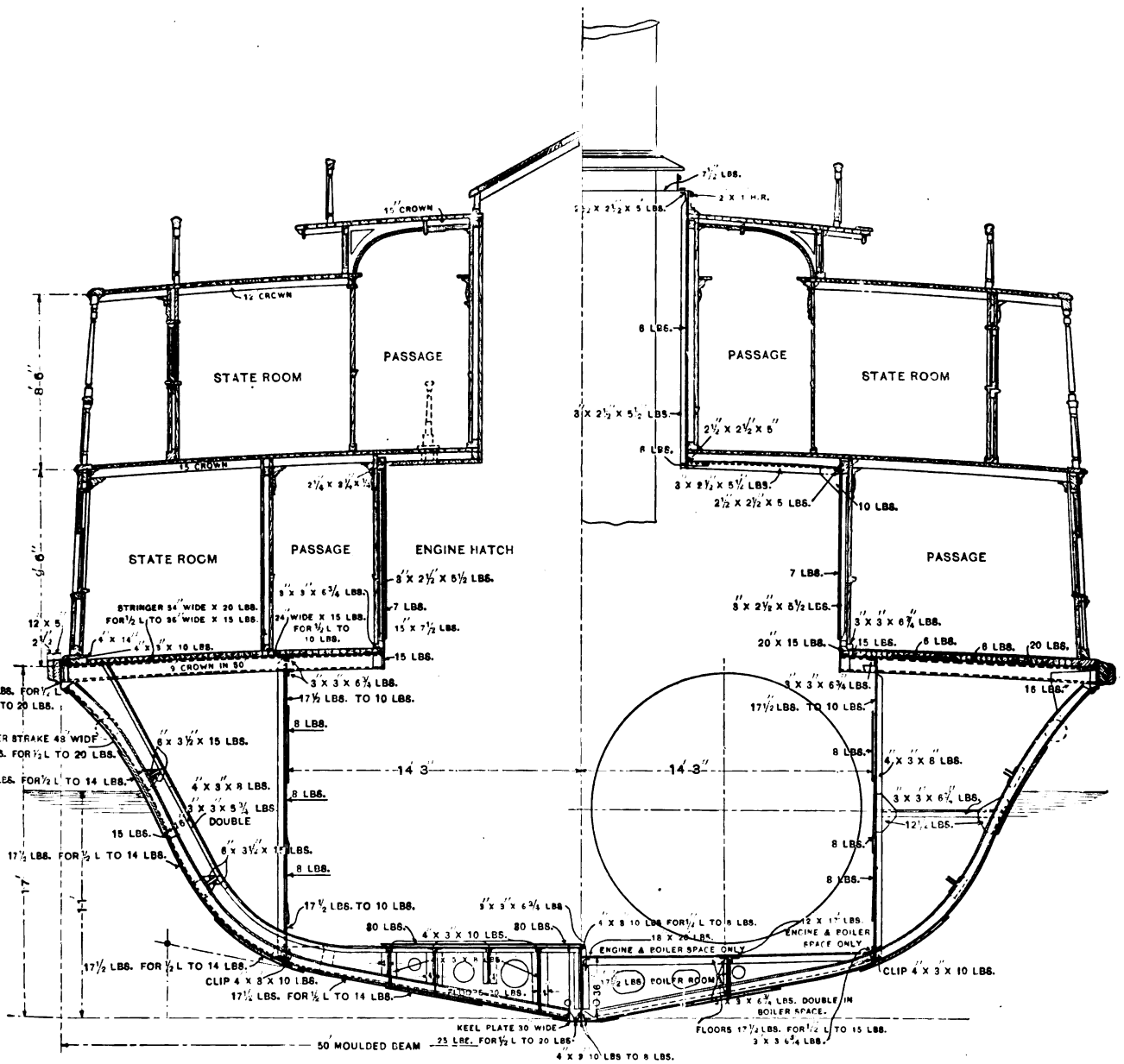
with piston valves at forward ends, are cast together. A heavy vertical lug cast on the forward side of the low-pressure fits in a recess on the after side of the intermediate-cylinder casting to steady the two castings.

cast-steel crossheads with taper and bolt. The block is bolted to cast-steel shoepiece of the slipper type; the guides are of cast-iron provided with water circulation. The shoe is babbitted front and back, and means are



BY WILLIAM CRAMP AND SONS SHIP AND ENGINE BUILDING COMPANY.

The cylinders are mounted on steel frames. The engines are designed to turn outward and so the inboard columns are fitted with crosshead slides. These columns are built up of plates and angles, as clearly shown in the engravings, one column supporting each cylinder. On the outboard sides the cylinders are held by two cast-steel I-beams. The columns, both front and rear, are bolted to a cast-steel bed plate with crosspieces which form the main journals. This bed plate is of I-section.

Piston rods are 4¾ inches diameter, and fitted into

provided for taking up the wear. The connecting rods are tapered, forked at the upper ends, and fitted with the usual form of brasses.

The piston valves are fitted with snap rings. The Stephenson double link motion is provided, controlled by a vertical steam cylinder working on the reversing shaft, which is on the outboard side of engine. The eccentric rods are of forged steel bolted to cast-iron straps. Eccentrics are of cast-iron, keyed to the shaft. On the intermediate and low-pressure cylinders there

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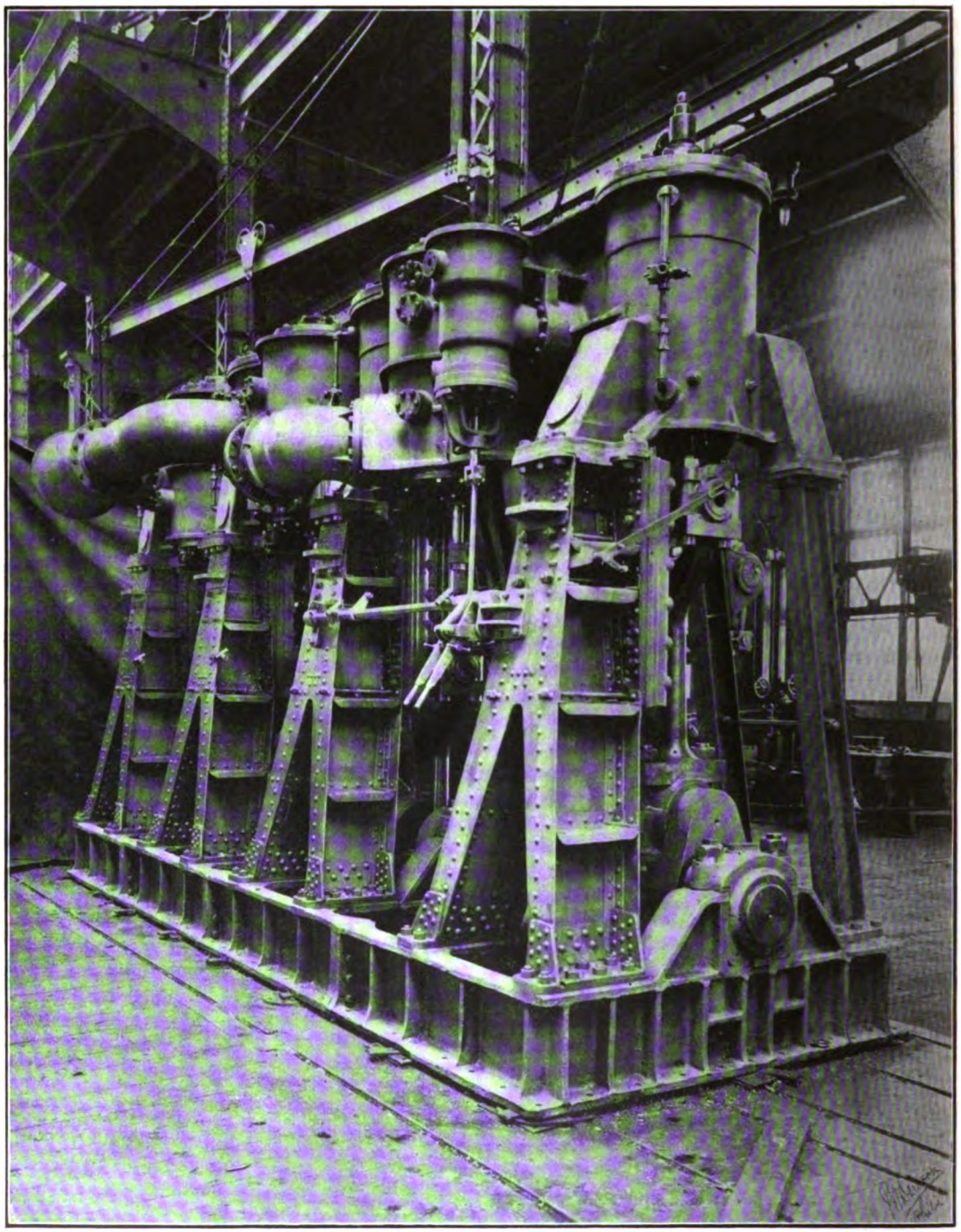
are two piston valves. Each pair of valve stems is attached to a yoke which has vertical bearing of hexagonal shape, and thus a greater wearing surface is secured. Katzenstein packing is used on rods and valve stems.

The thrust shaft is fitted with eight collars, between which are seven horseshoe bearings for taking up the forward and astern thrust. These bearings are placed in recesses in the after engine-room bulkhead and are mounted to framing bolted direct to engine bed plate.



PORT ENGINE OF THE ASBURY PARK, THE HIGH-PRESSURE CYLINDER IN THE FOREGROUND.

Crank shaft is of the solid and built-up type; that is to say, webs and crank are made out of solid forgings and these are shrunk and keyed on to the shaft. There are eight journals on each engine, with cast-steel tops. Crank-pin brasses of the usual form are fitted.

A gland is provided at each end of bearing, as the latter is in the form of a box and the shafts may be run in water. The line shaft is in three sections of 10¾ inches diameter, and the propeller shaft is fitted with brass sleeves bearing on the lignum-vitæ-lined stern tube.

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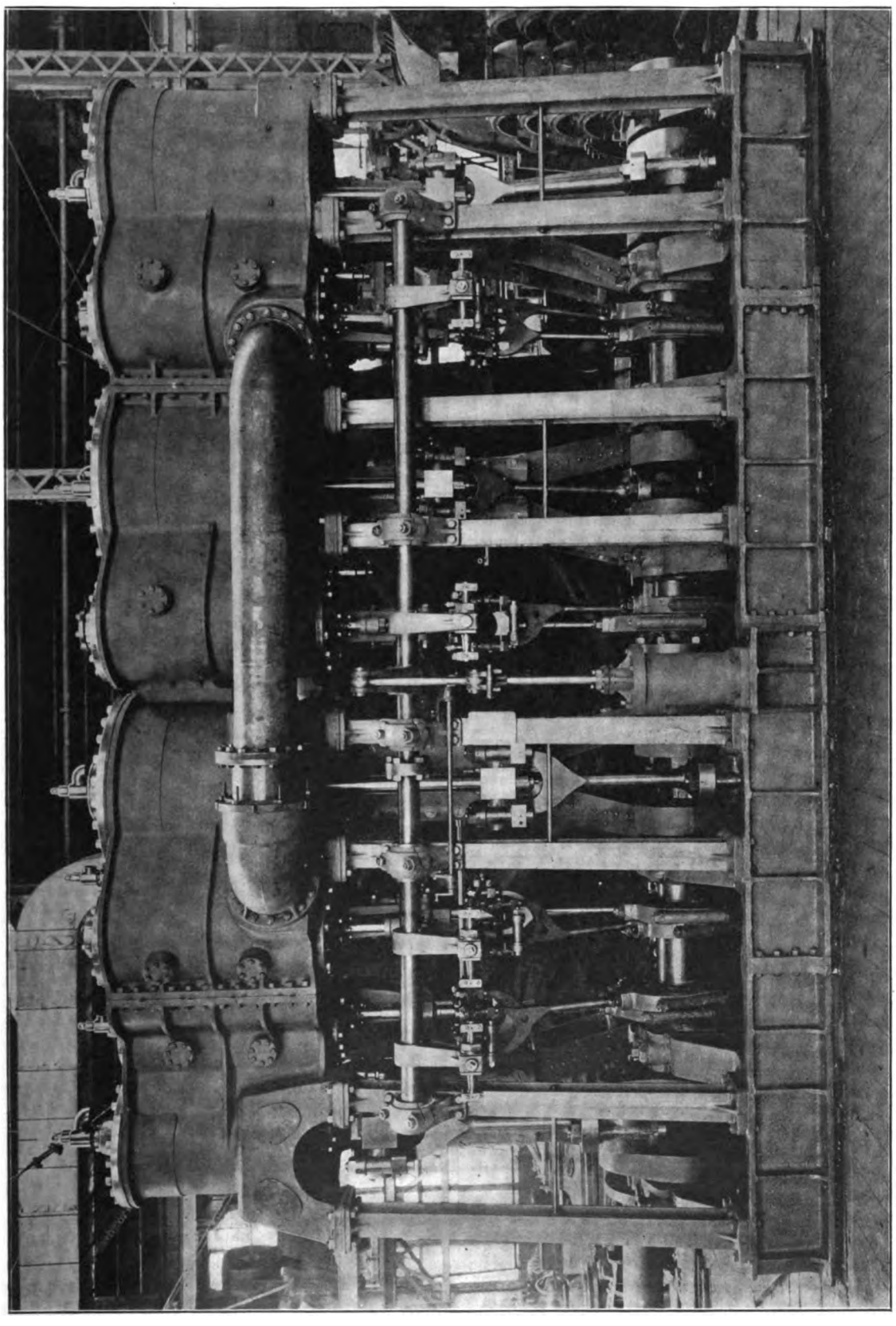

VIEW OF OUTBOARD SIDE OF FOUR-CYLINDER, TRIPLE-EXPANSION PORT ENGINE OF THE TWIN-SCREW STEAMER ASBURY PARK.

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The outboard bearing is carried by cast-steel brackets. The two propellers are four-bladed, of the built-up type, the blades of bronze and the hub of cast steel.

AUXILIARIES.

Steam exhausts from the inboard side of port engine low-pressure cylinders and from the outboard side of starboard engine into a large, common condenser placed across after end of engine room. This condenser has a steel-plate cylindrical shell, 15 feet long by 5 feet 6 inches outside diameter, and is fitted with copper tubes.

A double simplex vertical Blake air pump is placed on port side opposite the condenser, the dimensions being 10 and 20 inches by 16 inches. This pump is of the "featherweight" type and delivers into the hot well abreast of it. Water is raised, by a Worthington vertical duplex lift pump 10 and 7 by 10 inches, into the heater in the engine room hatch above. From thence the water falls by gravity to the main pump, of the same size and type, and is fed to the boilers. The lift pump may also be used as boiler feed by cutting out the feed-water heater. Into said heater steam from the dynamo and other auxiliaries may be exhausted. These pumps are placed on the port side. A large Blake duplex horizontal 12 and 8⅛ by 10-inch donkey pump is placed above the condenser for fire or other service. On the starboard side there are the following: A vertical duplex Worthington pump for sanitary purposes, 5¼ and 5 by 5 inches; a pump of the same pattern, 6 and 6 by 6 inches, connected for pumping out the bilge; and a centrifugal pump for circulating water through the condenser, driven by a 7 by 7-inch engine.

The filter tank and fresh-water tank are placed abreast of engine room on port side, and on the starboard side is a dynamo room, in which are placed two direct-connected sets of General Electric dynamos connected to engines. The capacity of the two dynamos is 25 Kw. and 8 Kw. In the upper engine room on either side are placed two double Sturtevant engines turning centrifugal blowers for supplying the forced draft of the Howden system to the boilers.

BOILERS.

Steam is supplied by four Scotch boilers arranged in two stokeholds; the after boilers are double-end and the forward boilers are single-end, with a common diameter of 13 feet. The length of the double-end boilers is 20 feet and that of the single-end boilers is 10 feet 6 inches. A passageway recessed in port wing coal bunker leads from the after to forward boiler rooms. Shells are 1 5-64 inches thick, designed for a working pressure of 175 pounds and tested by hydrostatic pressure to 263 pounds. The double-end boilers are fitted with six corrugated furnaces, each 38 inches mean diameter, and the single-end boilers have three similar furnaces. There are three combustion chambers in each boiler. Each chamber of the double-end boilers (into which the furnaces from each end open) is divided by a fire-brick wall. The tubes are 2½ inches diameter outside.

All boilers are fitted with Howden forced draft, nests of 3-inch vertical tubes being placed in the smoke boxes. The donkey boiler, placed on the main deck at the forward port end of casing, is of the vertical tubular type, 60 inches in diameter and 4 feet high.

Steam piping of the main engines is laid in two lines well up above the main deck. On the after side of the engine-room bulkhead a cross between the two lines is fitted. Throttle valves are placed at inboard side of each high-pressure cylinder. All high-pressure steam piping is of copper. There are eight safety valves provided, two on each boiler, with a total area of 102 square inches.

Ashes are hoisted from the stokeholds by small engines placed above the main deck, and are dumped into hand cars. The bunkers are filled through coal scuttles in the main deck.

Under trial conditions when at sea and when burning soft coal, retarders being fitted in the boiler tubes, the *Asbury Park* easily fulfilled her contract requirements and attained a speed of about 20.5 knots.

Name—Asbury Park. **Nationality**—American. **Type**—Fast harbor steamer.
Launched—1903. **Builder**—Wm. Cramp and Sons S. and E. B. Co. **Owner**—Central R. R. of N. J.

Length over all	307 ft. 0 ins.
" between perps	297 " 3 "
Beam at water line	42 " 8 "
" molded	50 " 0 "
" over guards	51 " 4 "
Depth, molded	17 " 0 "
Draft, load	11 " 0 "
Displacement, load	2,000 tons
Block coef	0.5
Tonnage, gross	2,078 tons
Passengers allowed	2,159
Engines: Number	two
Type	four-cylinder triple
Cylinders, diam	23, 37 1-2, 43, and 43 ins.
Stroke	30 "
Valves	all piston, 1 on H. P., 2 on each other
Shafting	10 3-4 ins.
Propellers	four blades each, built-up
Material	bronze blades. cast-steel hubs
Diam	9 ft. 6 ins.
Pitch	12 ft. 2 ins.
Area, developed, each	33 sq. ft.
Boilers: Type	Scotch
Number	two double-end, two single-end
Pressure, gage	175 lbs.
Diam	13 ft. 0 ins.
Length	double-end, 20 " 0 "
	single-end, 10 " 6 "
Furnaces, each	double-end, 6; single-end, 3
" diam., mean	38 ins.
Tubes, diam., outside	2 1-2 "
G. S., each	double-end, 48 sq. ft.
	single-end, 96 " "
" total	288 " "
H. S., each	double-end, 1,774 " "
	single-end, 3,833 " "
" total	11,214 " "
H. S. ÷ G. S	39
Trial: I. H. P., about	6,000
R. P. M	190
Speed	20.5
I. H. P ÷ G. S	4.80
H. S. ÷ I. H. P	1.87

Address Missing.—If the correspondent "Amateur," of San Francisco, will send his address his question will be answered by mail.

Cancel Crescent Cruiser Contract.—By order of Assistant Secretary of the Navy Darling, the government contracts for the protected cruiser *Chattanooga* and torpedo-boat destroyers *Nicholson* and *O'Brien* have been canceled. These vessels will be taken from the yard at Elizabethport, N. J., and completed at the government shipyards.

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INTERNAL LUBRICATION OF MARINE MACHINERY.

BY H. C. DURYEA, LIEUT. U. S. N.

The loss due to the friction of pistons, plungers, valves, and their respective rods at stuffing boxes, forms a large part of the total loss caused by friction; and the question of keeping these internal parts in proper condition to reduce this loss to a minimum and prevent their wear warrants considerable attention by those to whom the care of marine machinery is entrusted.

New difficulties in lubrication have been met in the use of high steam pressures and superheated steam, due to the very high temperature at which the ordinary lubricants are vaporized. The use of greater piston speed and pressures on wearing surfaces likewise has added to the problem.

Remedies suggested to secure the nearest to the desired conditions are:

1. Selection of best materials the friction between which is a minimum.
2. Efficient design.
3. Good and accurate workmanship.
4. Care and treatment to prevent the deterioration of the wearing surfaces.
5. Lubricants.

PROPER MATERIAL.

The materials for the internal wearing parts should be such that the coefficient of friction is as small as possible. Then a very smooth and hard surface can be obtained and one that requires relatively little lubrication besides the moisture of the steam. Hard, cross-grained cast-iron wearing on itself seems to meet these conditions better than any other practical combination of metals. When the cylinder and valve-chest liners are made of this material and with cast-iron rings well fitted, an extremely hard and smooth surface is the result without applying any lubrication but the moisture of the steam. The material should be as hard as it is possible to work it, the efficiency of the wearing surface depending in a great measure on its hardness.

EFFICIENT DESIGN.

The following points of design will effect smooth running very materially:

The spring rings or snap rings should exert a uniform and not an excessive pressure, and their surfaces should not be too great. Thus, if a ring 1 inch wide will be efficient in keeping a piston tight, making the ring 2 inches will only add friction.

Fitting relief rings on slide valves and balance pistons on piston valves always reduces friction and is the general practice of to-day.

The framing and other parts of the engine must be properly braced and stiffened to guard against vibration and the movement of the ship.

The stuffing-box packing should be designed to allow some side play, so as to follow the rods when they become somewhat out of line.

WORKMANSHIP.

Good workmanship will insure all parts being in line, all surfaces true, and all parts accurately fitted together. This includes boring the cylinders true, and finishing the valves and seats to a true surface and the rods to a uniform section.

If there are any material discrepancies in these points, good results cannot be expected to follow.

CARE OF SLIDING SURFACES.

This is accomplished by keeping all parts in line, preventing rusting, pitting, and scoring of cylinders, flats in rings or rods, and cutting of all wearing surfaces.

If cylinders or rings are allowed to rust, the true surface is at once destroyed and small particles of rust will grind and cut any of the wearing parts. Rusting in the cylinders is caused by the presence of both air and moisture. Moisture may be removed by well draining the cylinders and all steam pipes connected therewith; by the avoidance of pockets that cannot be drained of water; and by running the condenser for some time after engines are stopped, so that all possible vapor is drawn out of engines. When engine has thus been efficiently drained the low-pressure exhaust should be kept closed, especially if condenser is to be run at any time. In case there is no exhaust valve and it is desired to run the condenser, it is advisable to put the low-pressure valve on its center and thus prevent the vapor from condenser backing into cylinder and causing rust. Leaky stop and throttle valves will, of course, present conditions to allow rusting.

To keep out air, all parts of engine should be kept closed. Close the drains which open to the atmosphere, indicator cocks, etc., as soon as the engine is shut down. The cylinders of auxiliaries are most likely to suffer from rust due to leaky or partly closed valves, open drains, and the presence of various pockets where water can collect.

When engines are to stand unused for more than a couple of days, and after any lengthy run, the cylinders should be opened and wiped out with kerosene. This removes all rust, moisture, or other deposit that may have collected. Then adding a coat of vaseline will protect the surfaces from further rust or corrosion, as well as giving them a good lubricant.

Pitting in cylinders and internal surfaces is caused by acids which may be contained in impure oil, or from the action of oily deposit consisting of dirt, oil, and rust. Air collecting in pockets and becoming heated may also cause this.

Scoring is caused by hard particles left in the cylinders, and by the edges or ends of the rings nipping cylinder walls, resulting from countersunk bolts let in too far, shoulders worn in cylinder when piston does not overrun, or rings overrunning counterbore, due to lack of adjustment. Slightly rounding off edges of rings might prevent nipping, and providing efficient keepers for the ends will prevent ends vibrating or rings nipping walls. Excessive pressure on some parts may cause the surface to abrade and produce a flat. If rings do not fit well the wear will only be on certain portions; for although the ring in a manner adjusts itself, yet when moved at all the fit becomes worse than ever.

The piston rod being out of line will also cause excessive wear on one side of cylinder and piston rod. When boilers foam, particles of dirt contained in the boiler water pass into the engines and there raise havoc with all moving surfaces.

LUBRICANTS.

Vegetable or animal oils must never be used, on account of the acids, which, being easily driven off by heat,

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cause corrosion in the boilers. Mineral oils are largely used, but have a bad effect on the heating surface of boilers, causing lack of efficiency, burning, etc. Oils too freely used also cause piping, pump valves, and seats to deteriorate, joints in piping to leak, condensers to become less efficient on account of oil deposit, and in general cause an increase in repairs and falling off in economy.

With very high pressure or superheated steam ordinary oils are vaporized, or at least their lubricating value is greatly reduced, so that, as in the case of gas engines, lubrication has become a most important question. When somewhat moist steam is used the moisture in the steam acts as a lubricant, especially with cast-iron. With parts well fitted and steam not too dry, vertical cylinders will run satisfactorily without any lubricant except that applied when cylinders are opened; but a satisfactory lubricant will lessen the friction and wear very materially.

Flake graphite has the peculiar properties of not being affected, either chemically or physically, by any temperature encountered in a cylinder. It is not easily carried away from the wearing surfaces, can stand any pressure, and requires only an infinitesimal clearance space between surfaces. It has a high lubricating value and hardens and improves the wearing surfaces by filling up all the minute cavities and irregularities in the surfaces, giving, in a short time, a beautiful, hard-polished surface which requires relatively little lubricant.

Graphite may be applied in the following manner: Whenever cylinders or valves are overhauled, mix graphite with vaseline before applying to the surfaces, which insures a general distribution. On starting up, introduce graphite through an oil cup or indicator pipe. This can be done in a dry state, using an oil syringe, or the graphite can be mixed with water and put in just like oil. Adding it to cylinder oil adds to the lubricating value; but if best results, viewed from the standpoint of boilers and condenser as well as engines, are to be obtained, no oil should be introduced into any steam cylinder on board ship. While running, graphite can be added in the same way; but very little is needed, since it quickly distributes itself over the surfaces and, not like oil, it remains there. Whenever there are indications of the cylinder walls "squealing," a little graphite should be added. Some cylinders lubricated in this manner, that have not had a drop of oil introduced for years except that which might have come from swabbing rods, on being opened are found perfectly smooth and as bright as mirrors. The surfaces have a very fine coating of graphite, which keeps them from being dry and prevents abrasion.

The same results are obtained with valves and their seats—the surface is made smooth and hard, scores are filled up, and a tight and easily worked valve is the result.

In order that the piston rod may work with little friction in its stuffing box, it must be well lubricated. Most patent metallic packings have an oiling arrangement, but this should be supplemented by swabbing the rods. The addition of a little graphite to the stuffing-box cylinder oil will greatly improve its lubricating value and also serve to develop a hard and smooth surface, which is so essential to steam-tight working.

The packing that allows for side movement will keep the rod from wearing and preserve a tight joint much better than those which do not allow such play. Small rods, such as valve rods and rods of auxiliary engines which in many cases have no separate oiling device, should be swabbed to prevent cutting, or the wearing of the rod to a flat or taper, as well as to reduce friction. The primary feature of keeping a stuffing box tight is to keep a true cylindrical rod, and the peculiar properties of graphite produce a hard and smooth surface.

The small and often delicate secondary valves of steam-pump valve gear are made to fit quite tight, and often they become hot and dry and consequently stick. If oil is used in these it gums on the surface and this causes the valve to stick. Slight rusting also causes cutting, which interferes with proper running. The best treatment for these parts is: (1) Frequent overhauling, wiping off all parts with kerosene to clean, remove, and prevent rust, and supplying graphite to protect and develop the wearing surfaces. (2) Adding a small amount of kerosene, with graphite added, occasionally or when valve does not work properly. Kerosene serves to cut out and prevent rust; it has also no bad effect on the heating surface of the boiler.

It is often stated that pumps will not run without oil, but it is a fact that pumps using oil do not run as well as other pumps in which nothing but a little kerosene and graphite had been used for a long period.

WATER END OF PUMPS.

The lubrication of the water cylinders of pumps is frequently entirely overlooked. A great many pumps receive their lubrication naturally, as in the case of air and feed pumps from the oil in feed water, bilge pump from the oil contained in the bilge. But those pumps working on clean salt water—sanitary, distiller, and auxiliary condenser circulating pumps—do not have these sources of lubrication. Salt will deposit itself in some degree and is at once a cutting agent to plungers and pump cylinders.

Such pumps can be lubricated by placing a little grease mixed with graphite on top of the glands. This at once lubricates the rod and some of the lubricating material will find its way to the surface of cylinder, thus reducing friction and wear. The abnormal wear of plunger rods working in clean salt water may have often been observed.

These notes are the results of observation and investigation of seagoing experience, and as such view the matter from a practical standpoint. There is no doubt but that if the question of internal lubrication were well considered and investigated by those operating marine machinery, great reductions in overhauling, wear and tear, and anxieties in attendance would result.

Wireless Telephone.—By means of his wireless telephone A. F. Collins recently successfully transmitted speech between Hartford and East Hartford, with the Connecticut river intervening. The most successful experiments have been made with water as a connecting medium, and it is claimed that the system is especially useful for ferryboats and other harbor craft, as by means of it messages may be readily sent from one to another, regardless of the weather when the boats might be veiled in fog.

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SHIPS OF THE OLD NAVY.

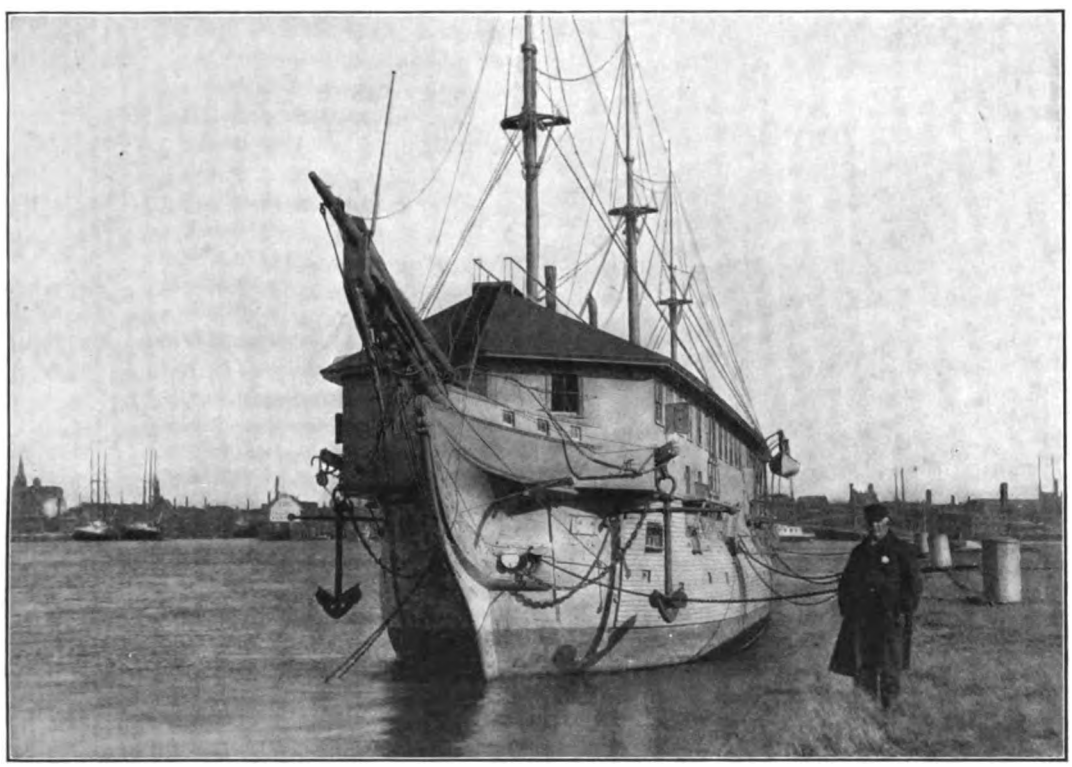
View it how we may, there is something pathetic in the passing of the old navy. The "wooden walls" with their mountains of canvas appeal strongly to a sentiment which is perhaps less easily awakened by the grim steel machines which have taken their place. Thought naturally turns first to the old *Constitution*, whose deeds in the war of 1812 have made for her a secure and undying place in the history of our country, and justify fully the efforts which have been made to give to her bodily form a like enduring presence, even though actually but a small part of the original timber could be preserved. If we attempt the preservation of no other like memento of that age of our history, the *Constitution*, at least, merits our best care, and we may hope that the day may be far removed when the gallant old ship shall finally pass from our view.

Between the sailing ship and the modern steamship there grew up, during the transition period of 1840 to 1870, a class of ships known as steam or sail auxiliary, and intended for use with either sail or steam, or even both, according as circumstances might favor. Thus were built the *Wabash*, *Lancaster*, and *Enterprise*. These vessels with their type have likewise all "passed" and only exist now on sufferance or by reason of glorious deeds associated with the name, as in the case of the *Hartford*, which won undying fame as Farragut's flagship in the naval operations at Mobile bay and elsewhere. The *Wabash*, *Lancaster*, and *Enterprise* are now used as receiving or training ships, and are thus continuing, in the well-earned quiet of old age, lives of usefulness spent mostly on distant and stormy seas.

The history of the *Constitution* is so well known, and her deeds in the war of 1812 have been made the subject of such extended notice, that only a brief summary of her career may be needed in connection with the view here shown of the ship in her present condition.

She was launched in 1797 and put to sea the following year for service against the French. During the war with Tripoli, 1801-1805, she was Preble's flagship and took part in three of the five bombardments of the port of Tripoli. In July, 1812, under the command of Isaac Hull, she made her celebrated escape from a British squadron off the New Jersey coast, and shortly after, on August 19, fought the famous battle with the *Guerriere*, which was left a total wreck after an engagement of only some thirty minutes. Later, in December, under Captain Bainbridge, she captured off Bahia, Brazil, the *Java*, after a two-hour engagement in which the British lost some 300 and the Americans 34. Still later, in February, 1814, under Captain Charles Stewart, she captured the *Picton* and a convoy in the West Indies, and in 1815 the *Cyane* and *Levant* after a fierce engagement, noted for the seamanship of the Americans and the unavailing valor of the English. Later she was pursued by a strong squadron which recaptured the *Levant*.

In routine service after the close of the war she was reported unseaworthy in 1828 and was ordered dismantled; but, in answer to Holmes' poem "Old Ironsides," popular sentiment was aroused and she was rebuilt in 1833. She again saw active service in all parts of the world, and was finally laid up in 1855 at Portsmouth, N. H. She was later used occasionally as a



FAMOUS UNITED STATES FRIGATE CONSTITUTION, LAUNCHED IN 1797, AND AS SHE NOW IS.
[This and the following five photographs were taken by T. E. Marr, Boston, Mass.]

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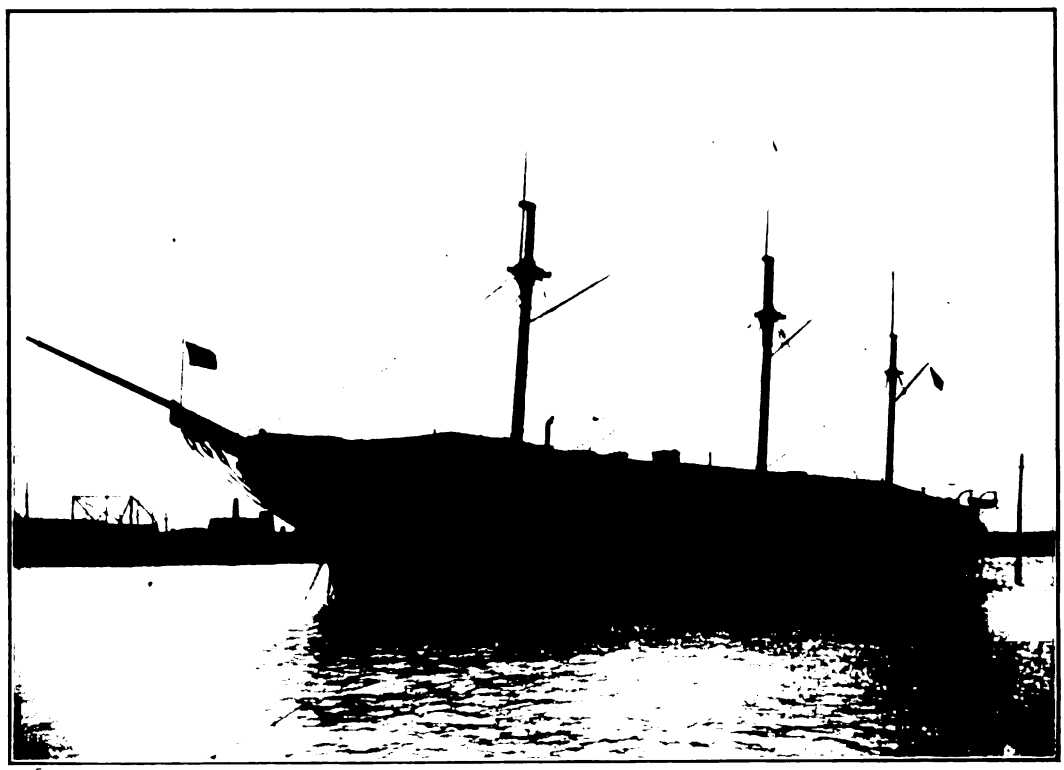
training or practice ship, and in 1877 was again partially rebuilt and crossed the Atlantic bearing the American commissioners and exhibit to the Paris Exposition of 1878. This was her last cruise abroad. Returning she cruised for a time on the home station, and was finally laid up at the Boston Navy Yard, where she still remains, as shown in the adjoining cut.

During the war of 1812 the *Constitution* fought three hard battles and several minor engagements. In Barbary she was engaged altogether in seven bombardments. During the whole period of active service she had but one captain killed and four lieutenants, and is said never to have lost a sail or spar except in battle.

Turning now to the *Wabash*, we pass at one step from 1797 and 1812 to 1854; from the age when the sailing ship was supreme to the age when steam was beginning to be recognized as a factor in navigation; and from the typical wooden sailing frigate to the intermediate type of wooden frigate with nearly full sail power and auxiliary steam power. The *Wabash* was authorized in 1854 and was built at the Philadelphia Navy Yard, being launched in 1855 and commissioned in 1856. Her length on the water line was 262 feet; beam, 51 feet; and displacement at load draft, 4,774 tons. Her cost was about $900,000. Even at this early period there were some far-seeing eyes who saw in the advent of steam an agency which must ultimately displace sails entirely, and it was proposed that these newly authorized ships should anticipate this tendency by being fitted with full steam power and with sails as an auxiliary. The old sailing ships, however, were too firmly secured in the love and pride of their officers, and the proposition was discarded with the intimation that it should be considered a sufficient concession that steam was admitted on any terms whatever. As thus built the *Wabash* was full ship-rigged, with a total sail area about thirty-two times the immersed midship section, which was a ratio only slightly less than that prevailing for full-powered sailing frigates. The form of the *Wabash* was somewhat determined by the fact that her frames were of seasoned live oak in stock at the Navy Yard; and in order that these could be worked up with a minimum waste, the form of the ship had necessarily to be adapted somewhat to the material in hand. The result seems to have been entirely satisfactory, however, and vessels of this class of frigates, consisting of the *Merrimac*, *Minnesota*, *Wabash*, *Niagara*, *Roanoke*, and *Colorado*, were justly considered as the superior of any war vessels then afloat. On their first cruise abroad vessels of this class were greatly admired and served as models for the constructors of foreign navies.



U. S. AUXILIARY STEAM FRIGATE WABASH, AT ONE TIME FLAGSHIP OF THE EUROPEAN SQUADRON, AND IN ACTIVE SERVICE IN THE CIVIL WAR.

Returning to the *Wabash*, her boilers were of the Martin vertical water-tube type—a form of boiler long since extinct in marine practice. There were four such boilers, each with five furnaces and a total grate area of about 335 square feet and heating surface of 12,540 square feet. There was, of course, but one funnel, fitted so as to telescope down when not in use and thus avoid interference with the sails and gear, as well as improve the appearance of the ship according to the standards of the day. It is of interest to note that a form of feed-water heater was fitted, the heat being derived from the supersalted sea water blown from the boilers in order to keep the degree of concentration down, as was the practice of the day.

The engines consisted of two simple, horizontal, con-

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SCENE ON THE GUN DECK OF THE U. S. TRAINING SHIP WABASH.

OFFICERS' PARLOR ON THE U. S. S. WABASH.

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densing cylinders, 72 inches in diameter by 36 inches stroke, motion being transmitted from piston rods to crank by a yoke, as in the once popular steeple type of engine. The steam valves were operated by Stephenson links, and cut-off was effected by the well-known Meyer expansion blocks on the back of the valve. The propeller was a true screw, two-bladed, 17 feet 4 inches in diameter and 23 feet pitch, fitted so as to disconnect from the shaft and hoist up in a well at the stern when the ship was under sail.

The steam pressure in the boilers was 13 to 15 pounds, revolutions 40 to 50, I. H. P. about 1,200, and speed 8 to 9 knots under steam alone.

The *Wabash* on her first cruise served as flagship on the home station for about two years, and then went to the Mediterranean for a third year, and returned home in 1859, where she was laid up till the outbreak of the Civil War. She was then placed in commission and saw active service on the coast blockading squadron, in the capture of Port Royal, and in other naval operations of the war. After the close of the war her period of active service was relatively brief. She was given an extensive overhauling in 1870-71, and in 1872 went as flagship to the European station. Returning in 1875 she was first laid up, and then assigned to the Boston Navy Yard as receiving ship, which position she has held since 1877.

The *Lancaster* is another of the ships of the transition period. Authorized in 1857 together with the *Pensacola, Brooklyn, Hartford,* and *Richmond,* she was launched in 1858 and went the following year to the Pacific station, where she remained as flagship until 1867. This assignment deprived her of all participation in the Civil War, in which her sister ships won such great glory. The chief dimensions of the *Lancaster* are as follows: length on water line, 235 feet 8 inches; beam, 46 feet; displacement, 3,290 tons. The boilers were of type similar to those in the *Wabash,* two in number, with seven furnaces each, and with an aggregate of 280 square feet of grate surface and 8,700 square feet of heating surface. The engines consisted of two horizontal, direct-acting cylinders, 61 inches in diameter by 33 inches stroke, fitted with jet condenser. The valves were three-ported slides fitted with Meyer cut-off blocks on the back. The original cost of the *Lancaster* was $568,769. For the original engines a pair of 60-inch by 36-inch Isherwood engines, built during the war, were later substituted, and in 1879-80 the hull was overhauled and remodeled with a ram bow.

U. S. TRAINING SHIP ENTERPRISE, ONE OF THE LAST WOODEN SHIPS OF THE NAVY.

Returning from the Pacific station in 1867, the *Lancaster* was overhauled and fitted with new machinery, as noted, and was then sent to the South Atlantic station, where she remained till 1876. She then returned home, was laid up at Kittery, repaired and saw successive terms of service on the European, South Atlantic, European, Asiatic, South Atlantic, and North Atlantic stations. In 1899 she was assigned to service as a gunnery and training ship for naval apprentices, and still finds usefulness in this work, in which she bids fair to round out a full half-century of honorable and useful naval service.

Passing to the *Enterprise*, we have a vessel authorized in 1873, when, in the reaction following the Civil War, the naval *matériel* had sunk to a low ebb. She was authorized in company with seven others, and the aggregate tonnage of the class was not to exceed 8,000

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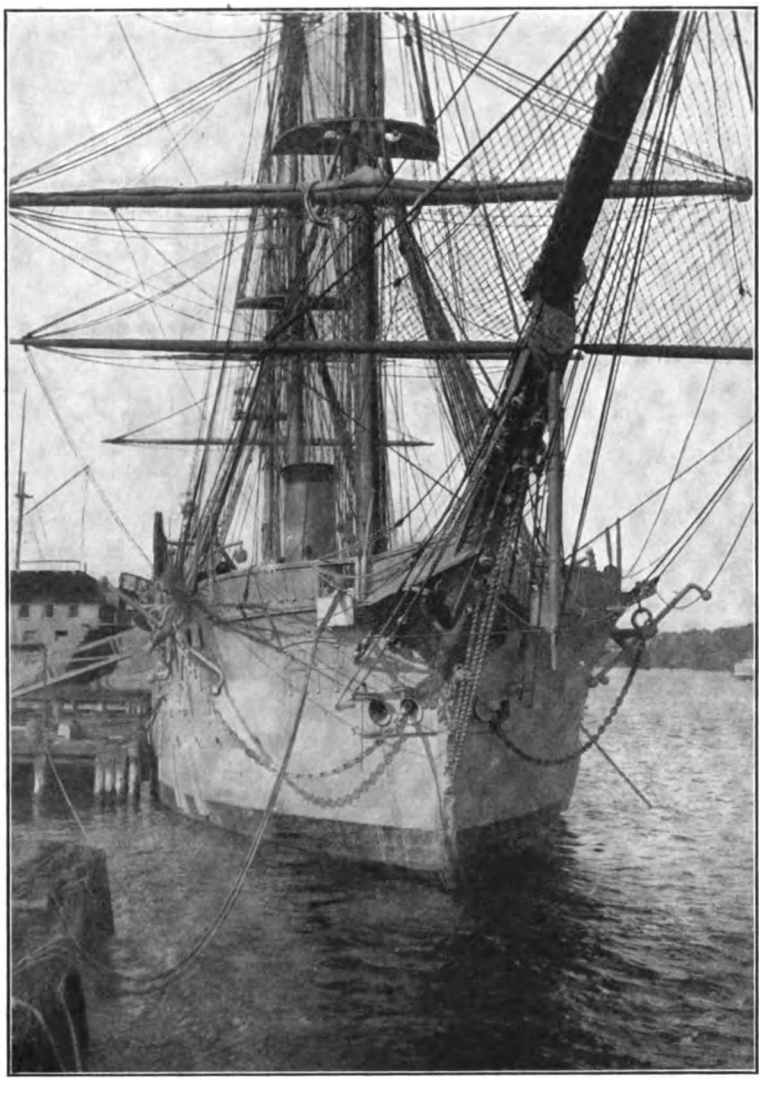
tons nor the aggregate cost $3,200,000. It is of special note that these vessels were defined in the act as "steam vessels of war with auxiliary sail power." The tide had now set strongly toward steam as a motive power, but sails were still retained as an auxiliary. In the *Wabash* and *Lancaster* the relation was reversed. There steam was the auxiliary; now it was sails. The *Enterprise* was built at the Kittery Navy Yard by a private contractor working in co-operation with the government officials. The machinery, however, was built at Hartford under separate contract. The length of the *Enterprise* was 185 feet; beam, 35 feet; and the displacement 1,375 tons. The boilers were single-furnace, cylindrical in type, and with an aggregate of 192 square feet of grate surface. The engines were of the horizontal compound type, with cylinders 34 and 51 inches in diameter by 42 inches stroke.

For her first commission, in 1876, the *Enterprise* was assigned to the North Atlantic station, followed in 1879 by special surveying duty on the Amazon and Madeira rivers in South America. She then saw duty respectively on the European, North Atlantic, Asiatic, European, and North Atlantic stations, and finally in 1894 was assigned duty as a Massachusetts state training ship, in which service she is still actively employed.

The *Enterprise* and class were among the last of the wooden construction in the navy. With these vessels the old era closed, and with the *Chicago, Atlanta, Boston,* and *Dolphin*, authorized in 1883, or ten years after the *Enterprise*, the upbuilding of the new steel navy was begun.



U. S. AUXILIARY FRIGATE LANCASTER, LAUNCHED IN 1858, NOW A TRAINING SHIP.

The ships here illustrated show the types of naval construction prevailing during the first three-quarters of the past century, and cover the last of the sailing-ship period and the earlier and middle development in the application of steam. The usefulness of these vessels as warships is past, and they remain simply as vestiges of an earlier stage of development, and as illustrating the progress in the art of naval construction during the period of time which they cover.

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STEAM TURBINES.—II.*

In closing the discussion Professor Rateau gave in brief the following description of his turbine:

The multicellular turbine in question is constructed by Messrs. Sautter-Harlé and Company, engineers, of Paris, and consists, as shown in Fig. 1, of a series of rotating wheels keyed on the turbine shaft, and separated by circumferential diaphragms held in grooves inside the turbine casing. The latter is in two parts, the section being on a plane which passes through the axis of the turbine. This allows the accurate fitting of the lower half of the system, which is then completed by putting in place the top half of the casing.

The wheels consist of buckled steel plates, conical in shape (see 4, Fig. 1), on the periphery of which are riveted nickel-steel blades, which are further held in place by a band. The fixed blades of the distributors (guide blades) are fitted on the periphery of the diaphragms (see 2, Fig 1), opposite the wheels.

The shaft runs through the diaphragms in bushes of anti-friction metal, with but little play—originally two-tenths of 1 millimeter. The shaft, however, makes its play when this is insufficient. There is no inconvenience attached to the friction of the shaft in the anti-friction bushes. Leakages of steam outside the distributors can only take place through this small windage, the total section of which is comparatively a very small one, owing to the small diameter of the shaft. The space between the wheels and the fixed parts is from 3 to 6 millimeters (.118 inch to .236 inch); there is thus no fear of their coming into contact. Should this happen, however, and a number of blades get broken, they could easily be repaired, even on board ship, as each blade can be removed individually and be replaced by another, fixed by one rivet only.

The steam flows through the diaphragms and wheels from the inlet at *A B* to the exhaust *G*, its pressure decreasing progressively, each successive wheel working under a low fall in pressure. The number of wheels varies from three or four to thirty and over.

The foregoing shows that all loss in efficiency through leakage between the fixed and movable parts has been prevented in a marked degree. It has been stated that with this system of turbine the friction of the wheels in steam leads to a notable loss. This is not the case, and in actual practice, with a turbine the dimensions of which have been carefully calculated, the loss of steam friction is only 3 to 4 per cent. of the power of the machine.

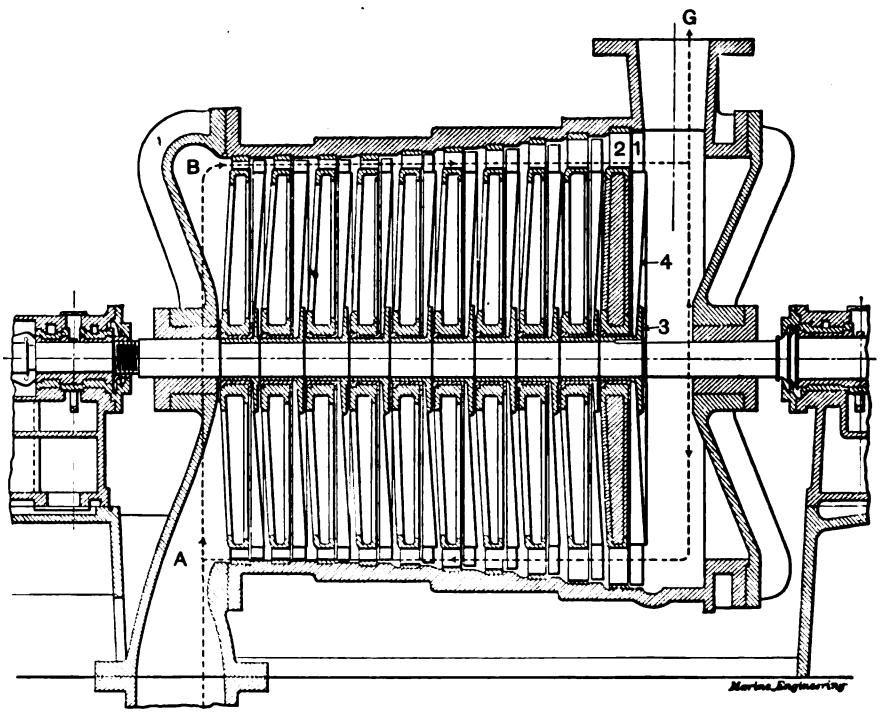

FIG. 1.—SECTIONAL VIEW OF THE RATEAU TURBINE.

The steam consumption is also very moderate, being, it is believed, lower than that of any other similar type of engine. These turbines are calculated with great precision, by formulæ based on theory and completed by experiments on the flow of steam; the difference between the calculated figures and the results obtained at the trials does not generally exceed 2 per cent., thus confirming the formulæ on which the *études* were first made.

The efficiency of these turbines is shown in the diagram, Fig. 2, which gives the results obtained at trial runs, made with the first of three turbines, coupled to a continuous-current dynamo, supplied by Messrs. Sautter-Harlé and Company for the generating station of a

*Discussion of Prof. Rateau's paper on this subject read at the Engineering Conference of the Institution of Civil Engineers, Section V., Shipbuilding, June 19, 1903, and taken from *Engineering*, London.

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mine at Penarroya, in Spain. The only motive engines in this station are the three steam turbines in question.

From the diagram, Fig. 2, it will be seen that the consumption of the turbine and dynamo under full load (500 horse power)—the inlet pressure being 8.5 kilograms per square centimeter (120 pounds per square inch), and the back pressure at the condenser .115 kilogram per square centimeter (1.63 pounds absolute)—was 7.03 kilograms (15.5 pounds) of steam per electric horse-power hour; and under an overload, at 640 horse power, with 11 kilograms (156.5 pounds per square inch) and .128 kilogram (1.82 pounds absolute) counter-pressure at the condenser, the steam consumption was only 6.74 kilograms (15 pounds) of steam per electric horse-power hour. These are good results for a 500-horse-power engine, seeing especially that the vacuum at the condenser was not very high. With a high vacuum such as the Hon. Charles A. Parsons can so

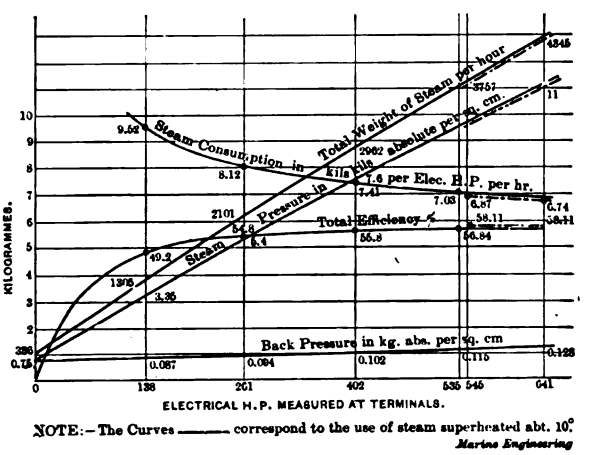

FIG. 2.—EFFICIENCY CURVES OF RATEAU TURBINE.

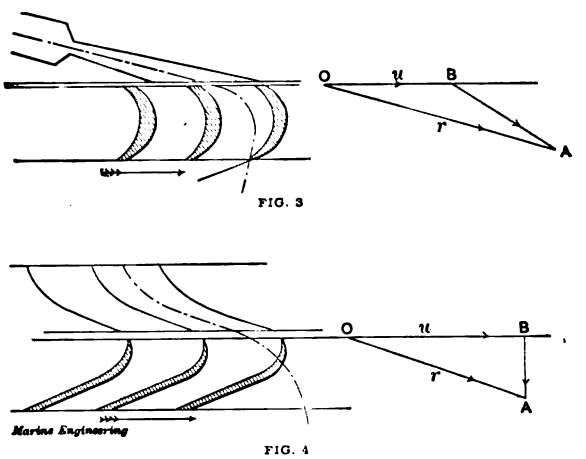

FIG. 3

FIG. 4

VANES OF IMPULSE AND REACTION TURBINES.

readily obtain, say .06 kilogram (0.86 pound absolute) back pressure at the condenser, the above figures of steam consumption would be reduced by 10 per cent. at least, and would be 14 pounds per electric horse power normally, and 13.4 pounds with an overload.

The diagram, Fig. 2, shows further that the total efficiency of the set, which rises to 58 per cent. at full load, remains approximately constant down to below half load; further, the total consumption of steam—the dynamo remaining excited and being self-exciting—does not exceed 336 kilograms (740 pounds) per hour running empty, being thus 10 per cent. lower than at full load. Mr. Rateau believes that no other engine gives such favorable results.

At the same meeting Mr. Cecil West Darley gave the results of trials made with a turbo-pump of the Parsons system, which raised water to a height of from 744 feet to 917 feet, its total efficiency being 31 to 35 per cent. Mr. Rateau has built similar turbo-pumps. One of these is of approximately 200 horse power, and raises water to a total height of 212 meters (700 feet), the output reaching 180 cubic meters (6,357 cubic feet) per hour. The total efficiency was 36 per cent.

About a year ago Mr. Rateau published the results of trials made with a turbo-pump which raised water up to a height of 1,000 feet. Messrs. Sautter-Harlé and Company are building at the present time a similar machine of 500 horse power, to raise water to a height of 1,200 feet, and when working at a pressure of 70 pounds per square inch the steam consumption is guaranteed not to exceed 10.5 kilograms (23 pounds) per useful horse power in water raised. This includes the working of the ejecto-condenser pump.

The question has been asked whether in the Rateau turbines the blades wear out rapidly. The inventor does not see any reason why the wear should be more rapid than in the Parsons turbines, for, owing to the number of wheels, the speed of the steam flow to each does not exceed 200 to 300 meters (660 feet to 990 feet) per second, equal, therefore, to that in the Parsons turbines.

In the turbines with one single wheel, such as the De Laval turbines, for example, the wheel blades wear rapidly; this is due to the fact that the steam, and the solid particles which it may draw with it, strike the wheel at a speed of 1,100 to 1,200 meters (3,600 feet to 3,950 feet) per second. The speed in the Rateau multicellular turbines being the quarter and even the fifth of this figure, it may be supposed that the wear under the striking action of the steam is much reduced, the shock being sixteen to twenty-five times less. Mr. Rateau referred to one of his multicellular turbines which had been working for about a year; it had never been opened, and he supposed the blades were not worn, as he had never found any reduction in its efficiency.

A question was also asked as to the cost of obtaining a good vacuum, or, in other words, what would be the change brought about by causing the vacuum to rise from 26 inches to 28 inches of mercury. Mr. Rateau stated that it was not his place to reply to this question; he only gave the results obtained with the ordinary vacuum. He was, however, quite of the opinion that it is advisable to ascertain what is the best possible vacuum; while, according to theory (as shown in abstract in the consumption formula he had given), on passing from a 26-inch to a 28-inch vacuum, the theoretical consumption per horse power for an inlet pres-

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sure of, say, 10 atmospheres, passes from 4.1 to 3.6 kilograms (9 to 7.95 pounds). There was thus a saving of about 12 per cent.; the supplementary work required, on the other hand, of the air and circulation pumps, which had to be larger proportioned, did not exceed 2 to 3 per cent.

The question of a governor for the engine was stated to be independent of the system on which the turbine was built. Any governor could be used for any turbine. As a rule, however, the governing of steam turbines was easier than that of reciprocating engines—first, because the moment of rotation was constant; and, secondly, because the flywheel effect of the rotary masses was comparatively much higher in the turbines than in the reciprocating engines. Therefore a governor which gave good results on a reciprocating engine would give better results still if used for a turbine of equal power. Messrs. Sautter-Harlé and Company have fitted to the turbines the successful type of governor they have designed for their reciprocating engines. This is provided with a speed compensator, and insures for permanent working a constant speed, whatever be the load. For sudden variations in the load, such as removing the full load, the "hunting" does not exceed 4 to 5 per cent.

The Hon. C. A. Parsons had stated that there was no essential difference between impulse and reaction turbines. Mr. Rateau said it was quite certain that they resembled each other, both having rotary wheels and guide blades. There were, however, essential differences between the two, and it was only necessary to open a treatise on hydraulic engines to see that hydraulic engineers attach great importance to the distinction between the two types. Mr. Rateau had not sufficient time to develop the reasons for the distinction, but stated that the speed triangle at the entrance to the wheel was very different in the one case from what it was in the other. Fig. 3 shows the speed triangle and the shape of the vanes of an impulse turbine, and Fig. 4 those for a reaction turbine (the latter in the Jonval type).

As the steam turbines revolve generally too fast for the work they have to perform, means have to be taken to reduce the speed, and one of them is to cause the turbine to work by impulse and not by reaction.

The Hon. C. A. Parsons asked how Mr. Rateau stood with regard to the trials of the *Libellule*, a boat ordered by the French Navy, and which is to be fitted with a turbine of his system. Mr. Rateau replied that it was not the *Libellule* which was undergoing trials at Havre, but torpedo boat No. 243, and these were to test the turbine. The *Libellule*, although provided with a steam turbine, was for the testing of another apparatus which is not yet completed. Preliminary trials were made with torpedo boat No. 243 during the summer months of 1901, and these immediately showed the disadvantages of an internal bearing, which resulted in a considerable oil priming to the condenser. This system of bearing was altered, and the trials were renewed during the summer months of 1902. Several runs were made in the open sea, which proved the perfect working of the turbines, without vibration and without oil priming. The speed contemplated had not, however, been reached so far. This was due to the difficulties met with in the action of the screw propellers, and which existed also in England at the commencement of the trials. The best system of propellers to be used in conjunction with steam turbines was being investigated up to last November, when the matter was dropped owing to an administrative matter, which had to be settled, relative to a special dynamometric device that had been provided for measuring separately the efficiency of the turbine and that of the propellers. The use of this device having appeared dangerous after the unfortunate disaster to the *Cobra*, it had been decided not to resort to it.

The trials are going to be renewed, the navy having taken another method for measuring separately the efficiency of the turbine and that of the propellers.

With regard to the anteriority of Tournaire as to reaction turbines with multiple wheels, Mr. Rateau said he had pointed it out as far back as 1890 in a paper to the Société de l'Industrie Minérale, St. Etienne, in the monthly report of March, 1900. It is stated also in the *Dictionnaire des Arts et Manufactures* of Laboulaye, 1877.

School of Naval Architecture at San Francisco.

With the increased growth of shipbuilding on the Pacific during the past two or three years there has come a correspondingly increased demand for technical training in naval architecture, and until recently there were no courses of study on this subject on the coast.

Last winter a course in naval architecture was established under the auspices of the Young Men's Christian Association Night School, and conducted by Mr. Vicente Legarda, a native of the Philippine Islands, who has spent many years in the Clyde district of the British shipyards. The course opened with a small attendance of apprentices, shipfitters, draftsmen, and carpenters, and has since then gradually grown in numbers. It was necessary to start at the very beginning with most of the men. The classes meet three evenings a week, Monday, Wednesday, and Thursday; the first two evenings are devoted to personal instruction in drawing and calculations, while every Thursday evening is taken up by lectures on naval architecture. The complete course extends over a period of three years.

In the elementary course of the first year the following subjects are taken up: Laying off and fairing, calculations of displacement, center of buoyancy and metacenters, methods of preparing construction drawings including details, also description of the screiveboard.

The advance course includes instruction in the following topics: Ship design, different coefficients, riveting, center of buoyancy, flotation and gravity, stability, strength of materials, ordering materials, etc.

The honors course takes up stability, bilging, oscillation of ships, local and structural strength of the ship, equivalent girder, tonnage, calculations of horse power and propulsion of ships.

Each course begins with the first week of October and ends March 31. A summer class is conducted for those who wish to prepare themselves for the regular work, which lasts from April 1 to July 1. At the end of each session a certificate of proficiency is awarded each student who has passed the final examination satisfactorily.

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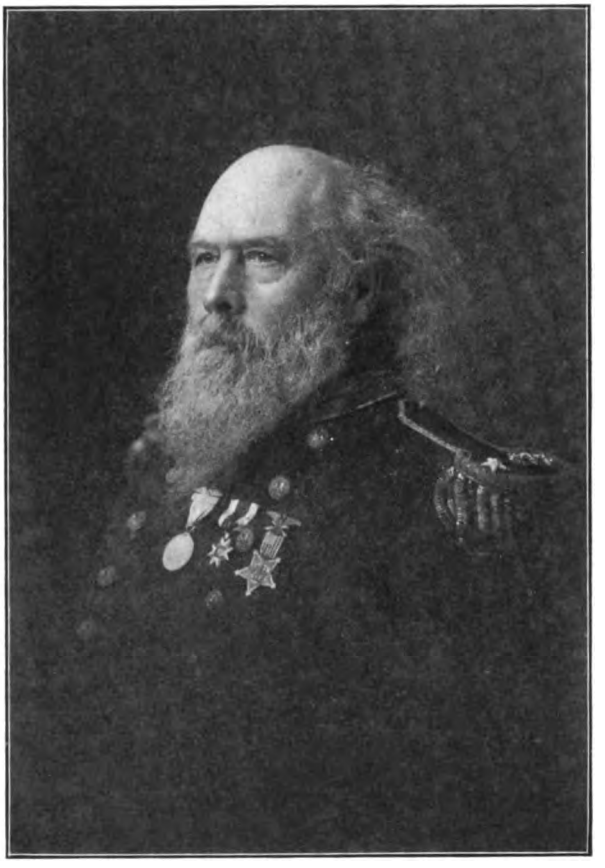
REAR-ADMIRAL GEORGE W. MELVILLE, RETIRED.

One of the few unfortunate results of the rule of retiring army and navy officers when they have reached sixty-two years of age is that of retiring Rear-Admiral George W. Melville, Engineer-in-Chief and Chief of the Bureau of Steam Engineering, U. S. N. Probably no man in the Navy, and certainly none in the engineering department, has been so conspicuous as this chief for force of character, executive ability, and perseverance, tempered withal with sound judgment. The Navy is losing in him a most valuable man from the active service, yet, according to the former practice of making use of conspicuous men on the retired list, he will doubtless be assigned to work on some advisory board.



REAR-ADMIRAL GEORGE W. MELVILLE, ENGINEER-IN-CHIEF, U. S. N.

Melville is a name conspicuous in Scotch history for energy in supporting the reforms in the days of Henry VIII. and James I., and the succeeding generations of this family did not hesitate to assert their belief even at the instance of death.

In 1804 James Melville, of Stirling, Scotland, landed in New York city, bringing with him a large family of sons; among them was one named Alexander, father of the subject of this sketch, who was born on January 10, 1841, in this city. He was educated in its public schools, then studied at the Brooklyn Polytechnic, and later took a course in higher mathematics in another academy. As his tastes inclined to mathematics and mechanics, he then entered the employ of James Binns, manufacturer and engineer, of East Brooklyn, and here he gained his first practical experience. As soon as the war broke out and the call came for men to uphold the unity of our country, Melville, who was not yet of age, stirred by patriotism and love of country, sought service under the flag and became an officer in the engineering corps of the United States Navy. Then began Melville's active service afloat.

At the time of the outbreak of hostilities there were but 69 vessels of all classes, of which half were sailing ships, in the United States Navy. Seeing the absolute necessity of an efficient blockade of the Confederate coast in order to reduce the rebellion, Gideon Welles, Secretary of the Navy, immediately undertook the assembling of immense blockading fleets, so that at the close of the year 1861 the government, through purchase and construction, possessed 211 vessels, and at the close of the war the number had grown to 600 ships of all classes. It was through the services of such men as Melville, able, resourceful, and possessing indomitable courage, that this fleet was made efficient and the sources of supply to the Confederacy from the outside world were effectually severed.

Melville served on many vessels, his first assignment

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being on the side-wheel steamer *Michigan*, on the Great Lakes. He was later assigned to vessels on the Atlantic coast and finally to the steam sloop-of-war *Wachusett*. It was while Melville was on board the *Wachusett* that this ship engaged in one of the most dramatic incidents of the war. She was refitting in the harbor of Bahia, Brazil, in 1864, when there steamed into port the Confederate cruiser *Florida*.

The observance of the international laws in regard to neutral waters should have, of course, prevented any combat taking place in the harbor, yet so intense was the feeling between the crews of the two ships that a Brazilian gunboat anchored between them and the guns of the forts were trained upon them. Captain Collins, of the *Wachusett*, sent a challenge on board the *Florida* for a naval duel to be fought at sea. The two vessels were evenly matched, as the Union ship was of 9 guns and 1,032 tons, while the Confederate had just been turned out from the Liverpool shipyards and carried a battery of two 7-inch rifles and six 6-inch guns. As a commerce destroyer the *Florida* had inflicted most severe damage to American shipping.

The challenge being declined, a council of war was held on board the *Wachusett* as to how to dispose of their antagonist, and Melville suggested ramming her. The objection was raised that the resulting blow would loosen the boilers on the *Wachusett* and sever the steam connections. Melville took the opposite point of view, and closed the argument by stating that it would be necessary for but one man to remain below after the engine was started, and that one would be himself. This plan was adopted, and at 2 A.M. on October 7 the *Wachusett* left her moorings and at full speed dashed into the *Florida*, ramming her on the starboard side abaft the beam, cutting her down 18 inches below the water line. The boarding party completed the victory and captured the surprised crew before they had time to offer much resistance.

Quick action was absolutely necessary before the Brazilian forts or warship should interfere. A hawser was made fast to the *Florida* and the *Wachusett* towed her out to sea, running the gauntlet of the forts, which had been awakened by the noise of the conflict. All this was accomplished in twenty minutes and without the loss of a single life, and the *Wachusett* towed her prize to Hampton Roads, Va., where the *Florida* was sunk.

Regarding this incident, Professor Soley says: "The capture of the *Florida* was as gross and deliberate a violation of the rights of neutrals as was ever committed in any age or country. . . . All that can be said is that it was the independent act of an officer and that it was disavowed by the government." He adds, however, as to the approval by the American people of the act: "The slight regard which, during nearly four years, neutrals had shown for their obligations toward the United States, and the use of their own territories which they had permitted to the Southern cruisers, had aroused in this country a just indignation and a deep-seated sense of wrong and outrage."

Many other interesting and daring incidents in which Melville took part during the war might be given, but suffice it to say that his courage, mechanical ability, energy, and engineering skill were generally recognized throughout the Navy.

In 1873 Melville saw his first Arctic service on board the steamer *Tigress*, which went to the relief of Captain Hall. He there imbued the spirit of the explorer, and six years later, when Lieutenant George W. De Long, U. S. N., started for the North Pole on the *Jeannette*, a bark-rigged steamer of 420 tons, Melville went with him as chief engineer. The story of the long cruise of the *Jeannette*, her final abandonment by officers and crew, of the fearful privations and sufferings of the crew from cold and hunger in those Arctic seas and lands, and the indomitable spirit and perseverance of Melville in searching for his commander, alone and unassisted, until he almost died in his tracks, are facts which have gone down in history to form part of the fearful records in the search for the North Pole. Repeatedly did De Long in his journal give glowing praise to his engineering chief for his resourcefulness, perseverance, and cheerfulness. The *Jeannette* sailed from San Francisco on July 8, 1879, and it was three years afterward that Melville and a few of the survivors returned. De Long and others had succumbed to the fearful hardships after the party had separated in whaleboats to sail across the open sea on their retreat southward; but it is solely to the credit of Melville that all the records and instruments of the party were recovered.

Melville never received any adequate recognition for this service, although ten years later a bill was passed by Congress advancing him fifteen numbers, which was half the numbers often given to men who had served gallantly in the Civil War. This was doubtless due to the friction between the engineers and the line officers of the Navy. It was not, however, for reward that Melville went to the Arctic, but for the real love of exploring; for in 1884 we find him again northward-bound with the fleet sent to the relief of the Lady Franklin Bay expedition. Later he was much interested in General Greely's expedition, although he did not go with him.

These incidents bring the history of Melville's life down to his service on shore. On August 8, 1887, he was appointed by Hon. William C. Whitney, Secretary of the Navy, engineer-in-chief. This appointment was distinctly one based on merit, for if Melville had any politics they were rather Republican than Democratic. He assumed the duties of this office just after the time that the rebuilding of our Navy had occurred; the four Roach cruisers had been completed. The unfortunate criticisms and condemnations of these vessels by Congressional committees which knew absolutely nothing about a steel ship, as is proved by the twenty years' efficient service of these four vessels, had inclined the department to purchase abroad plans for several cruisers. Secretary Whitney decided to change this policy and have the plans drawn for future vessels by members of his own staff. Melville readily and willingly undertook the design of the machinery for the first thoroughly American cruiser, later named the *San Francisco*, and from that time on all machinery for our Navy has been gotten out by the Bureau of Steam Engineering, the aggregate power of engines

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constructed or under way amounting to over one million horse power.

As is well known to all readers, a progressive policy has been the keynote of our Navy; not such progression as would run ahead of complete experimental demonstration, but such as is always looking for an improvement in or substitute for existing forms. Melville was early interested in the water-tube boiler. He did not, however, believe in selecting a single type and installing it in all vessels of the Navy, but rather in equipping different vessels with different types, to see by comparison which is the best suited to naval requirements. He was the first engineer-in-chief of any navy to take up the water-tube boiler, and the monitor *Monterey*, built on the Pacific several years ago, was fitted with Ward boilers.

His progressiveness has been shown in many ways, and he has strongly advocated the establishment of an experimental station at Washington wherein the new devices and machines which are brought out might be thoroughly tested and original research carried on for the benefit not only of our Navy but for general shipbuilding. At this point it is well to make note of the fact that Rear-Admiral Melville has at all times kept in touch with our merchant marine and been free to give to shipbuilders and the technical press the information of his department. He advocated publishing the plans of hull and machinery of new warships in the annual reports of the department, and it is to be regretted that this feature was discontinued because of pecuniary reasons.

Melville was solely responsible for the installation of the three screws in the cruisers *Columbia* and *Minneapolis*. In undertaking this design he was advised not to by his friends and co-workers, yet his belief in the system was so strong that he would not be deterred. The results were more satisfactory than even he had anticipated, for the speed obtained by these two ships was one knot in excess of that estimated and gave them a greater speed than any vessel afloat, except torpedo boats, of their day. This custom has been followed by all foreign navies except that of Great Britain, and, although the admiral still favors the system, no further vessels in our Navy have been equipped with three screws.

He at all times has advocated high speed, and when, a few years ago, the question arose of duplicating the design for battleships with a speed of 16 knots, he stood out alone for 18-knot ships, and it was through his untiring efforts, assisted, as he acknowledges, by the shipbuilders and the technical press, that the Board of Construction gave the competitors an opportunity to submit designs for 18-knot ships. These later designs were so eminently satisfactory that the speed of 18 knots was decided upon.

At the outbreak of the Spanish war Melville fitted out two novel types of vessels; one was the repair ship *Vulcan* and the other the distilling ship *Iris*, both of which have proved their usefulness as auxiliaries to the fighting fleet.

Extensive experiments were carried on, under the direction of the engineer-in-chief, with liquid fuel. A model boiler room, representing one on board ship, was fitted up and most exhaustive tests were made with oil as fuel. The report on these experiments has been published and forms one of the most valuable works on the subject.

So far we have touched upon only the professional ability of Melville. His record shows, however, that he has at all times been most aggressive in furthering the interests of the engineers, and the amalgamation of engineers and line officers under the Personnel Bill was largely the result of his untiring zeal. Up to that time engineers were given only a relative rank as professionals, and there was continuous conflict between them and line officers. The duties of the engineer afloat have yearly increased since steam was first used as an auxiliary, and the engineering department has so developed that its officers have larger executive duties to perform. In 1897 the Personnel Board was called together to consider this condition and report to Congress. It was presided over by the then Assistant Secretary of the Navy, Theodore Roosevelt. As a result of its considerations the bill providing for consolidating the engineers with the line officers was favorably reported and eventually passed. With strict justice we believe it is not going too far to state that this result would not have been reached for many years had it not been for Admiral Melville's magnificent work in the administration of his office, coupled with his splendid personality. While there have been setbacks to this system, which aims at giving every officer an engineering training and experience, yet the general results have been so good that Great Britain has recently made a similar move.

If one would inquire of the men who have worked under Rear-Admiral Melville, they would find that he inspires tremendous enthusiasm and loyalty among all. He is a shrewd judge of character and has selected for his assistants men of great ability. Doubtless part of this loyalty is a result of Melville's attitude toward the men, for he at all times gives them full credit for their work. He is too broad-gage a man to desire to detract from his assistants' work and take the credit on himself.

As before noted in these columns, the rear-admiral was relieved from duty on August 8, this year, and thus completed sixteen years of continuous service as head of the Department of Steam Engineering. Fortunately it finds him in robust health, with a prospect of many more useful years of active life before him. In these sixteen years marine engineering has made tremendous strides, largely because of increased demands for ships to carry our commerce, yet such strides have only been made possible through hard work and research of the engineer, and it is to Melville that we may extend our thanks and look with pride for his inestimable service in this direction—a service marked by a never-failing energy, heroism, and enthusiasm.

Data Cards.—Marine Engineering was in no way responsible for or connected with the *Engineering Data Card Magazine*, published last year in Richmond, Va., and now discontinued. So many inquiries have reached this office concerning data cards that hereafter all data which have appeared in special card form in Marine Engineering since July, 1903, will be reprinted on standard 3 by 5-inch cards and sold at a nominal figure to subscribers.

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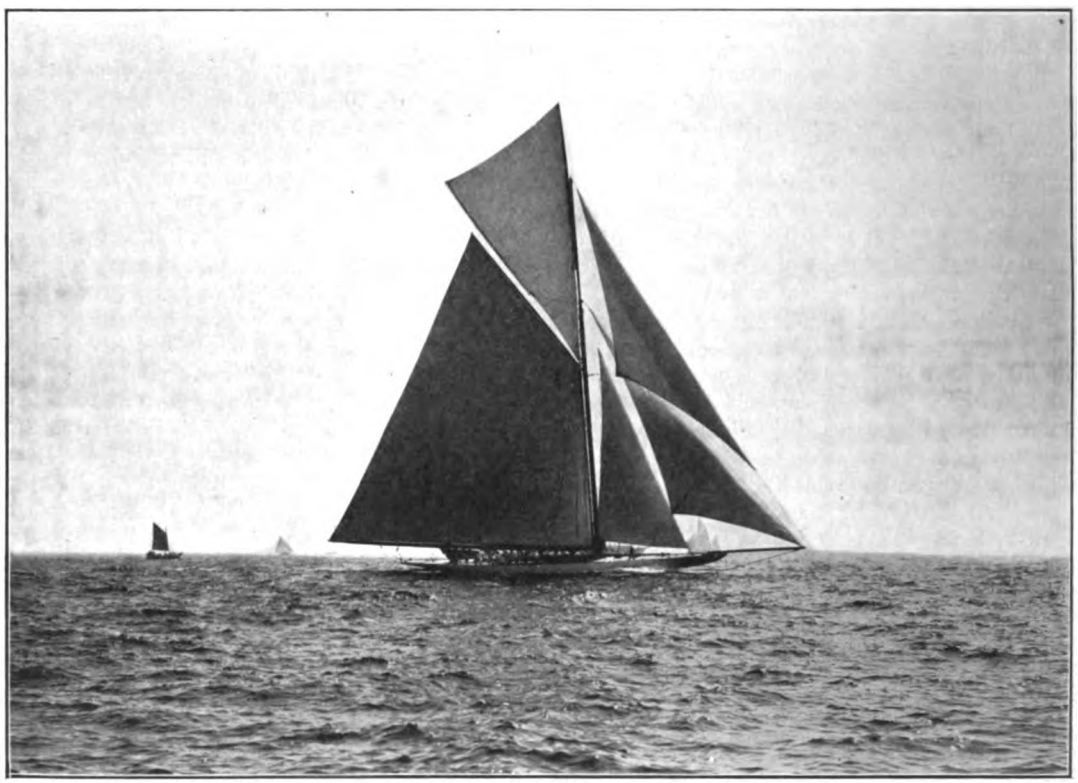
Agreement Between the British Government and the Cunard Line.

An important agreement has been entered into by the British government with the Cunard Steamship Company for the building of two fast mail steamers. At a meeting of the shareholders of the company, Lord Inverclyde explained that they had been called together to obtain sanction to such alterations in the articles of association, and in the capital of the company, as were required to enable the directors to enter into and carry into effect the agreement with His Majesty's government. As they had been advised, the basis of this arrangement was settled nearly twelve months ago; but there had been an immense amount of detail to arrange with the four government departments—the Admiralty, the Post Office, the Board of Trade, and the Treasury—with which they had had to negotiate. Further, they had had to deal with many important questions in their negotiations with the proposed builders of the new ships. From the outset the basis of their agreement with the government had remained as stated in the circular; and as the terms of the actual agreement had not yet been approved by the House of Commons, he was precluded from going more particularly into its provisions. In substance, during the term of agreement the company was to remain a purely British undertaking—British as to its shareholders, British as to its ships, British as to its board and officials, and British as to its management and control. Further, the company was to add at once to its fleet two large steamships of high speed for the Atlantic trade; and these two vessels and the whole of the rest of the fleet were to be held at all times, during the currency of the agreement, at the disposal of the government for either charter or purchase at fair and reasonable rates. In return the government was to lend to the company on approved security the money to pay for the building of these two ships at 2 3-4 per cent. per annum, and they were also to pay the company from the time the new ships began to run £150,000 per annum.

The law for generations had limited the right to carry the British flag strictly to British subjects, and it had provided for forfeiture to the Crown of any vessel upon which this rule was not observed. A company registered in Great Britain was treated for all purposes as a British subject, even if every shareholder or director were a foreigner living outside the jurisdiction of our government. The law being as it is, the government, not unnaturally, in dealing with the Cunard Company, had insisted upon their remaining in the future what they had been in the past—a British company not only in name but in fact. At present not more than 1 per cent. of their capital was held by foreigners. Such foreign shareholders would be entitled to remain in the company for as long as they pleased; but for the future they would accept only fellow-subjects as co-owners with them of their vessels. They proposed to accept the government or its nominees as fellow-shareholders, and to attach to the share to be issued to them such a number of votes as would enable them to prevent any alteration being made against their wishes in the above-mentioned clauses. This agreement was passed.



RELIANCE CROSSING THE LINE AT THE FINISH IN THE SECOND OF THE SERIES OF THE INTERNATIONAL YACHT RACES, AUGUST 25, DEFEATING SHAMROCK III. BY 1 MINUTE 19 SECONDS, CORRECTED TIME.

[Photograph by T. C. Muller.]

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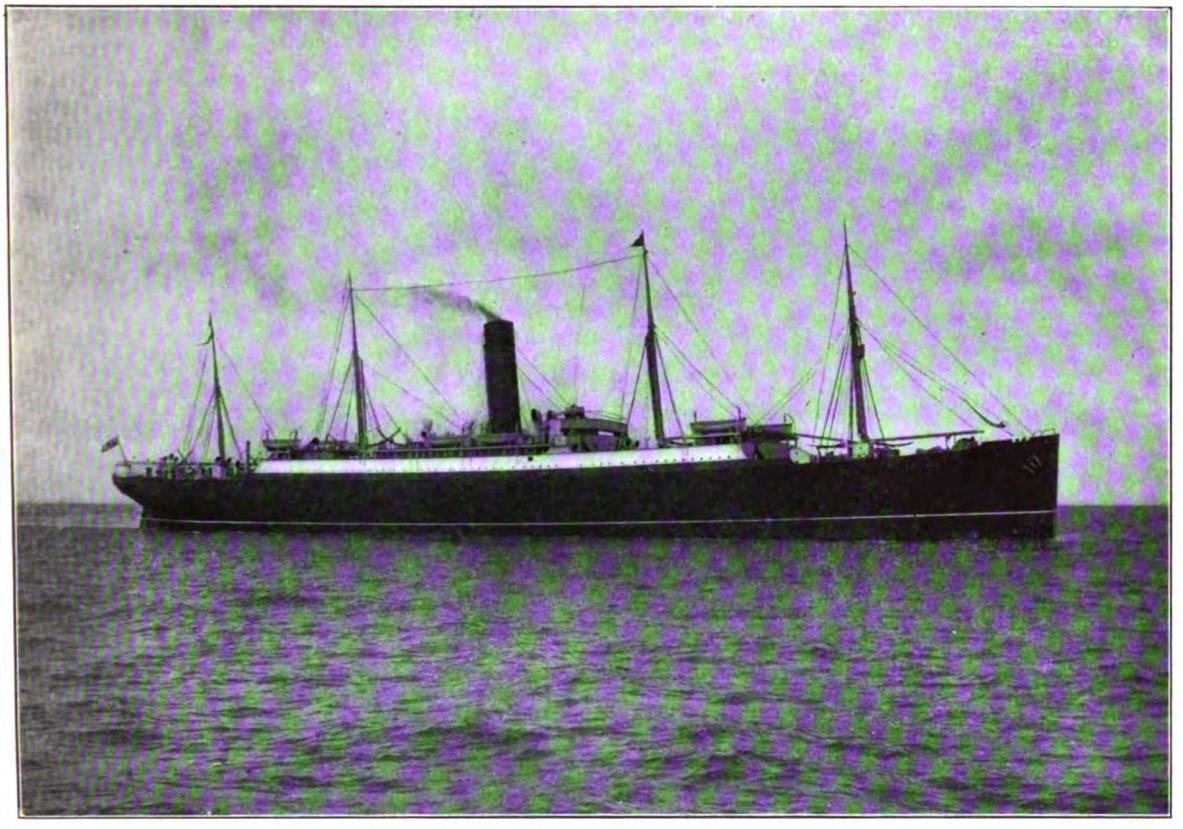

TWIN-SCREW CARGO AND PASSENGER STEAMER CARPATHIA, OF THE CUNARD LINE.

STEAMSHIP CARPATHIA.

There has been reported in these pages the introduction of many new ships to the transatlantic trade during this past season, all of which are of English build. One of the latest to enter the New York service is the twin-screw steamer *Carpathia*, of the Cunard Line, built by C. S. Swan and Hunter, and engined by the Wallsend Slipway and Engineering Company, both of Newcastle-on-Tyne. The *Carpathia* is of the intermediate type, and is only fitted with second-cabin and steerage-passenger accommodations, the rest of the space being devoted to carrying cargo. She much resembles the *Ivernia* and *Saxonia* in the Boston service of this line. She is rigged with four pole masts and one stack, and the midship house extends two-thirds the length of the vessel, beginning directly aft the foremast. There are three deck houses on top—the forward one for officers' quarters, the main one just aft the mainmast, and the after one at the after end of the midship house. At the break of these houses are hatches to the cargo space below. The second-cabin accommodations are located amidships on the bridge and shelter decks. The dining saloon is forward on the shelter deck, paneled in ivory, white, and gold, the furniture being of mahogany and upholstered in bright tapestry. The dome is of stained glass, and above this is a large fan, electrically driven, for insuring abundant supply of fresh air. The pantries are amidships, and the galleys, baker shop, etc., are on the port side of the shelter deck. Above the dining room is a library well equipped with writing tables, lounges, and bookcases. It is entered from the main hallway, from which the stairs lead to the deck below. The smoking room, which is on the after part of the promenade deck, is paneled in walnut and comfortably fitted. There is, in all, accommodation for 200 passengers in this second cabin.

The third-class accommodations are well equipped in comparison to the practice of a few years ago. On the upper deck is a large dining saloon, well fitted up and well lighted. On this deck there are also provided a ladies' room and a smoking room. The accommodations are ventilated and heated throughout by mechanical means. Fresh air is forced through large pipes into various compartments by means of thermo tanks, consisting of large fans driven by electric motors, which pass the air over coils. In winter time these coils are supplied with steam.

The *Carpathia* has been found to be a very comfortable boat in rough weather. The accommodations for the officers, as above mentioned, are on the bridge deck, and the seamen and firemen are under the bridge deck on the port side, and the stewards are at the forward end of the upper deck. Cargo is handled by Wilson winches. A windlass is placed on the weather deck forward, and warping capstans are at both ends of the vessel.

MACHINERY.

The builders of the engines have endeavored to make this a most economical job. There are two sets of four-cylinder, four-crank, quadruple-expansion engines, and the arrangement of the cylinders and valves is as follows, from forward aft: piston valve, high-pressure cylinder,

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low-pressure cylinder; balanced slide valve; piston valve, second intermediate-pressure cylinder, first intermediate-pressure cylinder, and piston valve. Each cylinder and its valve is a single casting and is supported on cast-iron columns front and back. There are cross columns between the engines at either end. The air pump is worked from the second intermediate crosshead, and the condenser shell is made of plate and is supported by brackets cast on two of the back columns. The crosshead has guides on front and back columns, provided with water circulation, and is of the usual type. The shafting is from Armstrong, Whitworth and Company and is of hydraulic-forged fluid compressed steel. The guides for the valve stems are in the form of brackets, forming part of the reversing shaft bracket, and thus independent of the cylinder. To each cylinder are fitted Ripper's mean-pressure indicators, by which the mean effective pressure in each end of the cylinder may be read through the gauges placed on the engine-room platform.

The auxiliaries consist of two sets of Weir feed pumps working in conjunction with Weir patent feed-water heater; centrifugal circulating pumps; two evaporators; auxiliary feed pumps; fresh- and hot-water sanitary pumps; ballast pumps, and an auxiliary condenser for handling the condensed steam for deck and auxiliary machinery. There are two sets of Allen compound engines, each direct-connected to a 450-volt, 100-ampere electric generator running at 305 revolutions. These are placed on the main deck over the after end of engine room.

The 7 single-end Scotch boilers are fitted with Howden's system of forced draft. There are two fans placed in the engine room, one on either side, and each is driven by an Allen simple engine; a spare engine is attached to each shaft in case of breakdown. The boilers work at a pressure of 210 pounds and are all placed in one large boiler room with two stokeholds. There is one funnel of large diameter with total height of about 120 feet above grate bars. A Crompton ash hoist is fitted in each hold, which consists of a long tube, its lower end being connected to the condenser. In this is placed a piston, to which is attached a wire cable running over sheaves and down the ventilator. To raise the ashes, the bucket is hooked to the lower end of this wire, the valve connected to the condenser opened, and a vacuum formed behind the piston draws the piston down at once, raising the ashes. An automatic device is attached whereby the

LOOKING DOWN ON THE WEATHER DECK FORWARD ON BOARD THE CARPATHIA.

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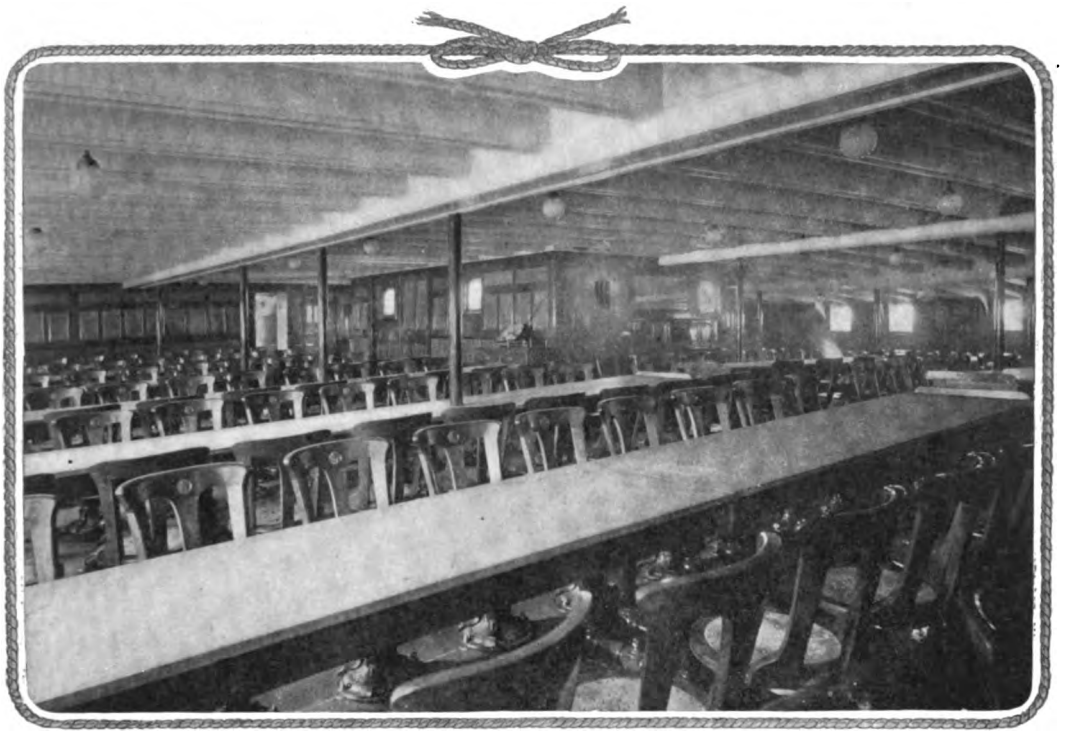
valve is closed when the ashes are raised to the desired height and the ashes dumped on the deck. The device is, indeed, most simple, easy to install, requires but very little space, has no parts to get out of order, and is noiseless. In case it is desirable to operate it when the condenser is not running, a vacuum is created by a steam nozzle. It is understood that the *Carpathia* is running very economically, averaging for several trips a horse power on 1.3 pounds of coal per hour.



THIRD CABIN DINING SALOON.

SECOND CABIN DINING SALOON ON THE TWIN-SCREW STEAMER CARPATHIA

Unfortunately, owing to the rules of the Cunard Com-

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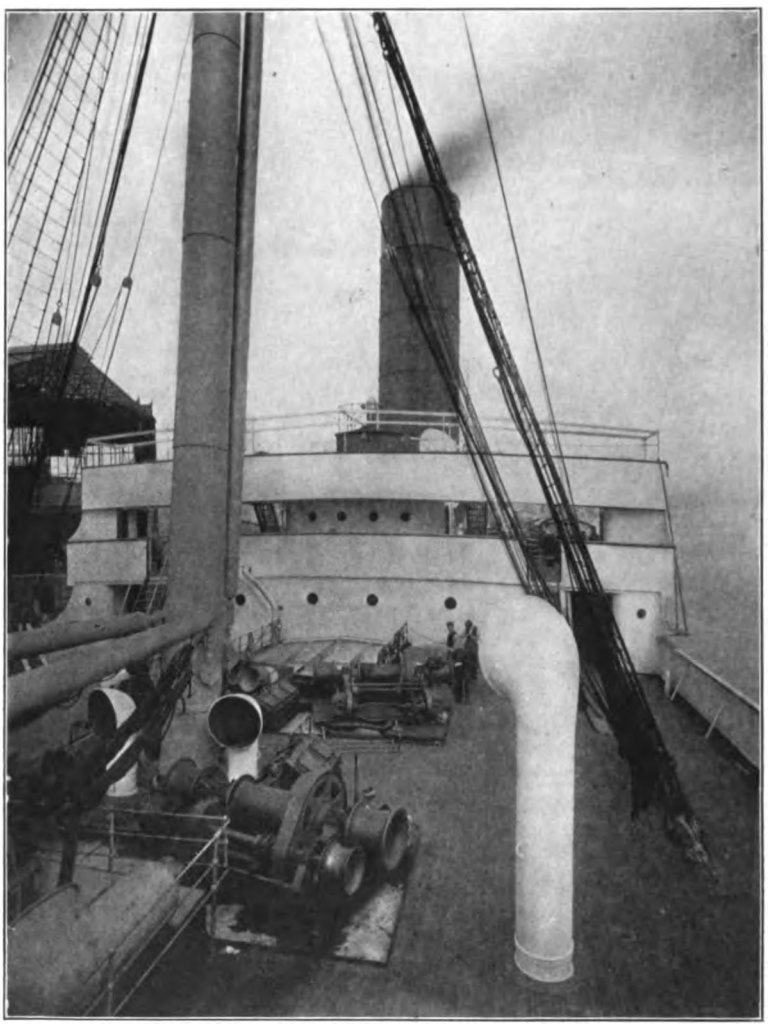
pany, no dimensions of machinery or hull, other than those given in the appended table, are obtainable.

Length over all	558 ft.
Breadth	64 " 3 ins.
Depth	40 " 6 "
Gross tonnage	13 555 tons
Displacement at load draft	24 000 "
Dead-weight carrying capacity	12 500 "



LOOKING FROM THE BOW ON BOARD THE CARPATHIA, SHOWING ARRANGEMENT OF WINCHES AND HATCHES.

Engines: Type	4-cylinder, quadruple-expansion
Cylinder diameters	26, 37, 53, and 76 ins.
Stroke	54 ins.
I. H. P.	9,000
Valves	piston, except on L. P.
Boilers: Number	7
Type	single-end Scotch
Steam pressure	210 lbs.
Furnaces	3 each
Draft	Howden

New Steam Yacht Czarina.

One of the largest steam yachts to be added to the fleet of American-built boats this season was launched on April 4 from the Crescent Shipyard, Elizabeth, N. J., and was christened the *Czarina*. She was built to the order of Mr. Charles S. Bryan, of New York, according to his ideas for having a specially heavily-built vessel which might be converted into a gunboat without the necessity of having strengthening plates fitted under her decks. The armament which she is prepared to carry would consist of two 3-inch rapid-firing guns, one starboard and one port, two 6-pounders, one mounted forward and the other aft, all mounted on the cabin deck; and four machine guns placed on the bridge deck. The over-all length of the *Czarina* is 172 feet, and other dimensions as to hull and engines will be found in the accompanying data card.

The arrangement of the cabins is well shown in the plans on page 522. There is but one deck house, extending for 100 feet in length. This is made entirely of mahogany with panels inside and outside. The music saloon is at the forward end and is fitted with heavy

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plate glass windows and Venetian blinds with portable stone shutters. From the entrance hall, stairs lead to the main saloon below, and a doorway at the left hand opens into the owner's room, which extends the full width of the deck house and has a bath room adjoining. Aft of the collision bulkhead on the main deck is a large state room, entered through a passageway, from which open the locker space and toilet room. The main saloon has a library and large couches, which may be used for beds, aft of which are two large bed rooms, toilet, and state room. The central part of ship and deck house are entirely devoted to engine and boiler space. The dining saloon, pantry, and galley are at the after end of house, and directly below are the officers' quarters, consisting of state rooms, mess room, and toilets. The crew's quarters are at the stern.

HULL SPECIFICATIONS.

The keel is of rolled bar iron, 1 1-4 inches thick by 6 inches deep, and is made up in lengths of 15 feet. The stem is also of rolled bar iron, 1 1-4 inches thick by 6 inches deep. The stern framing is of the best quality of forged steel, with stern post, rudder post, shoe, and arch in one forging. The stern post is 2 1-4 by 5 1-2 inches, with at least 1 1-2 inches of metal around the hole for the stern tube. The rudder post is 2 1-8 by 5 1-2 inches, with gudgeon, etc., forged on.

The frames are angle bars, 2 1-2 by 2 1-2 inches by 4.1 pounds, spaced 22 inches apart. Reverse frames are angles, 2 1-4 by 2 1-4 inches by 3.6 pounds, and extend 6 inches above the bilge stringer. In the machinery space they are double across the tops of floors, and every alternate one is carried up to the deck. There are also three belt frames in the machinery space. They are made of 8-pound plate, 9 inches wide, and fitted on the inboard edge with two angles 2 1-4 by 2 1-4 inches by 3.6 pounds.

The floor plates are placed on every frame and are of 10-pound plates, 21 inches deep. In the engine space and under the thrust bearings they are of 12 1-2-pound plate. The center-line keelson is made of 12.5-pound plates, 24 inches deep, with continuous bulb angles, 6 by 3 inches by 3 pounds, on top of floors. There is a side stringer on each side, of double angles, 2 1-2 by 2 1-2 inches by 4.1 pounds, connected to the stem by gusset plates 36 inches long by 10 pounds. The inner bottom is formed of 7.5-pound plate. In the wake of the tanks 10-pound plating is used. The plates are flanged on top and connected to the outside plating by 2 1-2 by 2 1-2 inch by 4.1-pound continuous angles, and to the floors by angle clips 2 1-4 by 2 1-4 inches by 3.6 pounds.

There are four water-tight steel bulkheads with angle staples at the keelson and stringers. The plating used is 5 pounds and 7 1-2 pounds. The angle stiffeners, 2 1-2 by 2 1-2 inches by 4.1 pounds, are spaced 27 inches apart. There is one horizontal stiffener on each bulkhead, level with the lower deck beams. It is formed of double angles, 2 1-2 by 2 1-2 inches by 4.1 pounds.

The coal bunker is formed of 5-pound plates stiffened by angles, 2 1-4 by 2 1-4 inches by 3.6 pounds, spaced 22 inches apart. There are four coal scuttles, 16 inches in diameter.

The deck beams are 4 by 3 inch by 7.1-pound angles. The main deck stringer plate is 20 inches wide by 10 pounds for half the length amidships, tapering down to 15 inches by 10 pounds at the ends. It is secured to the sheer strake by 2 1-2 by 2 1-2 inch by 4.1-pound angles.

There is a steel deck of 5-pound plating over the engine and boiler rooms and also over the coal bunker. The outside plating is built up in six strakes, in and out. The sheer strake is about 36 inches by 15 pounds for half the length and 12 1-2 pounds at the ends. The garboard strake is 27 inches wide by 14 pounds. The bottom and bilge strakes are 12 1-2 inches wide by 10 pounds, and the remaining strakes are 10 pounds.

The rudder is made of a wrought-iron frame forged in one piece. The stock is 3 3-4 inches diameter at the head and 2 inches diameter at the heel. The rudder frame is filled in with white pine and rosin and covered with 7 1-2-pound plates.

The deck planking is of well-seasoned white pine 2 1-2 inches by 2 1-2 inches. A steam steerer, No. 112 1-2, with a 3 1-2-inch engine in the engine room, was furnished by Williamson Brothers. The steering wheel is of hard wood, inlaid, 36 inches diameter. The wire rope running to the tiller is 1-2 inch diameter. The quadrant is formed of angles and wrought-iron arms. A spare tiller has been so arranged that it can be instantly connected, should the occasion demand it.

There are four boats and one liferaft, as follows: one 24-foot motor boat, one 24-foot cutter, one 20-foot gig, one 14-foot dinghy. The liferaft is of steel.

There is a supply tank, with a capacity of about 3,000 gallons, located in the forward hold. It is made of 3-16-inch steel galvanized. There is a fresh-water tank, with a capacity of 110 gallons, located in the deck house above the boiler room. This is made of 10-pound steel plate galvanized.

MACHINERY.

The vessel is driven by a vertical, triple-expansion engine of about 1,800 indicated horse power; the cylinder diameters are 14, 22, and 36 inches, the common stroke being 24 inches; the main valves on the high-pressure and intermediate are of the piston type, and the low-pressure is fitted with a double-ported slide valve; all are worked by Stephenson link motion with double bar links fitted with steam reversing gear. The front columns of the engine are of forged steel, and the back columns of cast iron resting on condenser, which forms part of the engine framing.

All pumps are independent of the main engine and are of the Davidson make, consisting of the following: one vertical beam air pump, having one 7-inch steam cylinder, two 11-inch air cylinders, with a stroke of 12 inches; one vertical duplex feed pump, 7 1-2 and 4 1-2 by 8 inches; one vertical duplex donkey pump, 7 and 4 1-2 by 8 inches; two horizontal single-cylinder sanitary pumps, 3 and 4 by 4 inches.

The yacht is well equipped with other auxiliaries, such as refrigerating and ice-making plant and electric lights. A searchlight is placed on the bridge, and a rainbow of incandescent bulbs runs from bowsprit to the after rail, leading over foremast and mainmast heads. A row of bulbs has also been placed from the awning-ridge rope as well as the smokestack.

Two Mosher boilers furnish steam at 250 pounds pressure. The principal elements consist of a steam drum, 32 inches in diameter by 8 feet long, placed at

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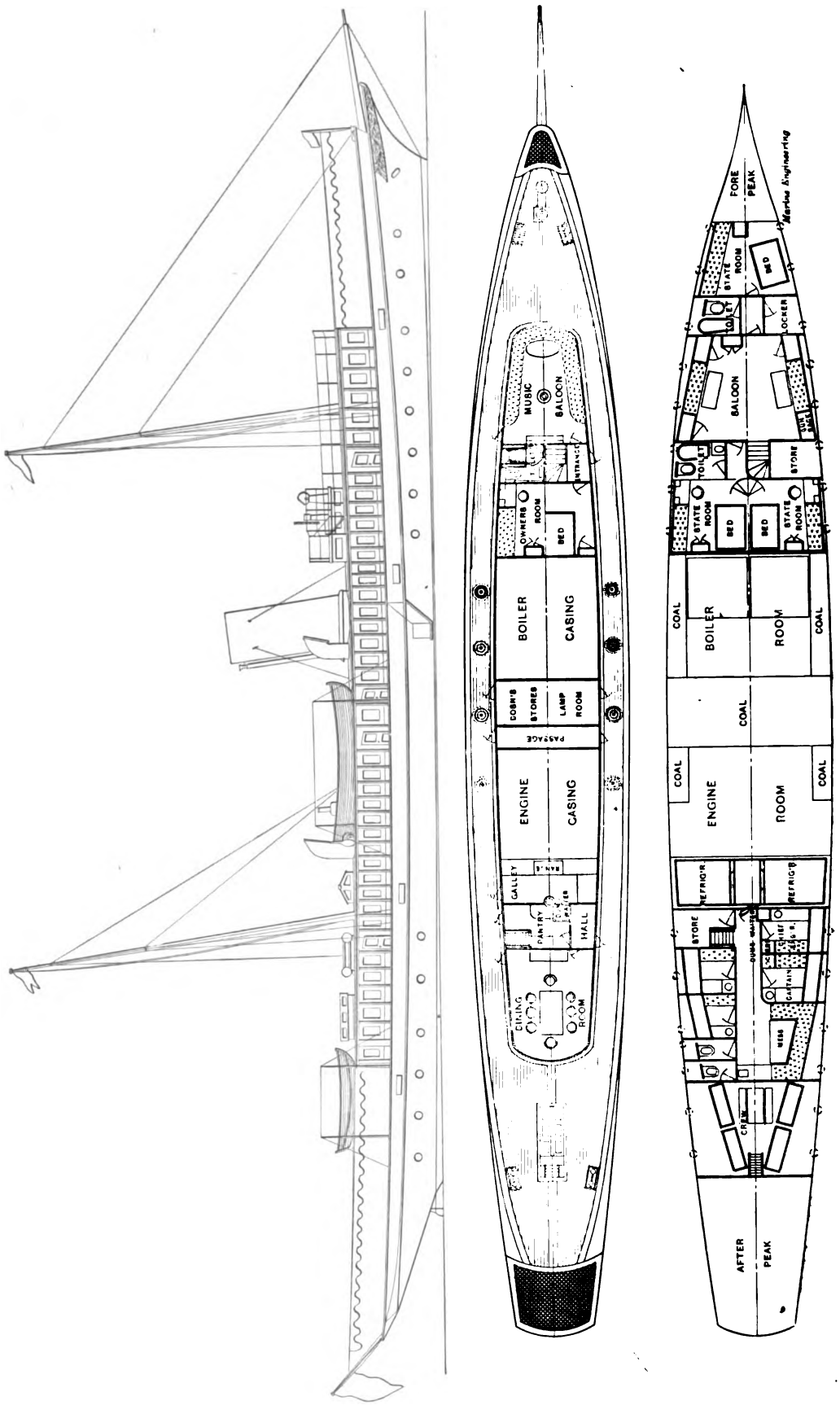

OCEAN-GOING STEAM YACHT CZARINA, BUILT AT THE CRESCENT SHIPYARD.

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the front and top; a water drum, 24 inches wide by 16 1-2 inches high by 8 feet long, placed below at the back of boiler (one-half of it is almost semi-circular, and the other half, in which the tubes are inserted, is of much greater radius); and between these two drums extend the water tubes, 1 1-2 inches outside diameter and 533 in number. The steam drum is supported by return pipes which are run down under the base and along each side of the grate back of the mud drum. The tubes in this boiler are so curved that all of one vertical nest are in line with a plug in the front of the drum; thus, by the removal of the plug, the tubes may be withdrawn or replaced through these openings. Five vertical rows of tubes may be withdrawn through a single plug hole.

Steam is taken from the main steam drum through a dry pipe and then through a superheater back of boiler into main steam pipe for engines.

Above the boiler, and mounted on the same casing with it, are air-heating tubes for heating the air supplied the boilers on the induced-draft system. The tubes are inclined in the same direction as the water tubes, and exhaust gases circulate round them before reaching the fan which exhausts them to the uptake.

NAME—Czarina. **NATIONALITY**—American. **TYPE**—Steam yacht.

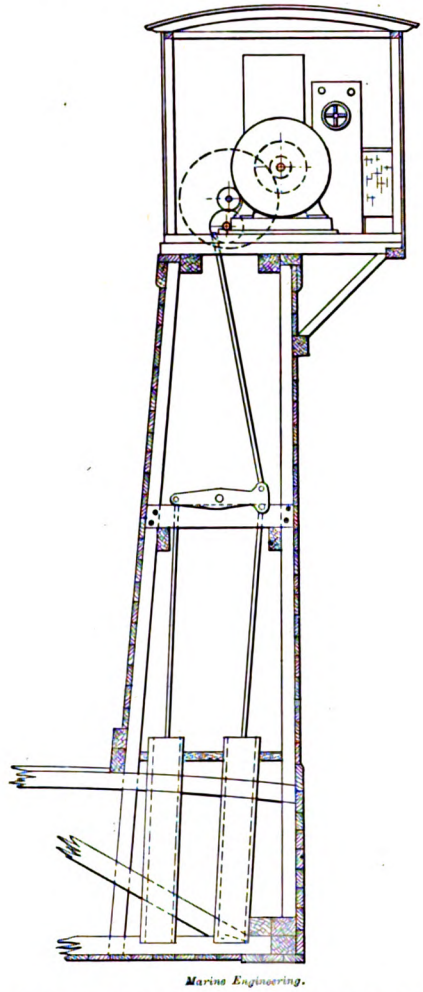
LAUNCHED—1903. **BUILDER** Crescent Shipyard. **OWNER**—Charles S. Bryan.

Length over all	172 ft.	**Stroke**	21 ins.
" between perps	140 "	I. H. P.	1,800
Beam, molded	22 "	Steam pressure	250 lbs.
Depth	12 " 6 ins.	**Boilers:** Number	two water-tube
Draft	9 " 6 "	H. S., two	2,720 sq. ft.
Displacement	300 tons	G. S., "	80 " "
Engines: Number	1	Tubes	1 1-2 in. O. D.
Cylinder diams	14, 22, 36 ins.	" number, each boiler	533

Electrically-Operated Floating Dry-Dock.

The balanced floating dry-dock, photographs of which are shown herewith, was built by James Tregarthen and Son Company, foot of Seventh street, East river, New York. It is of the well-known balanced type, which has demonstrated its fitness for a great variety of dry-docking work and is justly so popular in this country.

The dock is 260 feet long on keel blocks, 186 feet 4 inches length of body, and is 85 feet wide. It has a depth at center of 10 feet 4 inches, and a height of wings of 34 feet, sufficient to take a draft of 20 feet



SECTION OF WING OF DRY-DOCK, SHOWING PUMPS.

over 3-foot keel blocks. The dock is divided by a center longitudinal bulkhead, four side longitudinal and six cross bulkheads into fourteen water-tight compartments, each of which is provided with two pumps.

These pumps, which are all arranged along the deck of one wing, are of the standard dry-dock pattern, 14 inches square and 20 inches stroke, all operated by a 100-horse-power electric motor.

This motor was especially designed for the work under specifications of Faber du Faur and Donnelly, engineers, by the C. and C. Electric Company, and is a special application of the series-parallel system of control. The speed of the motor is 475 revolutions per

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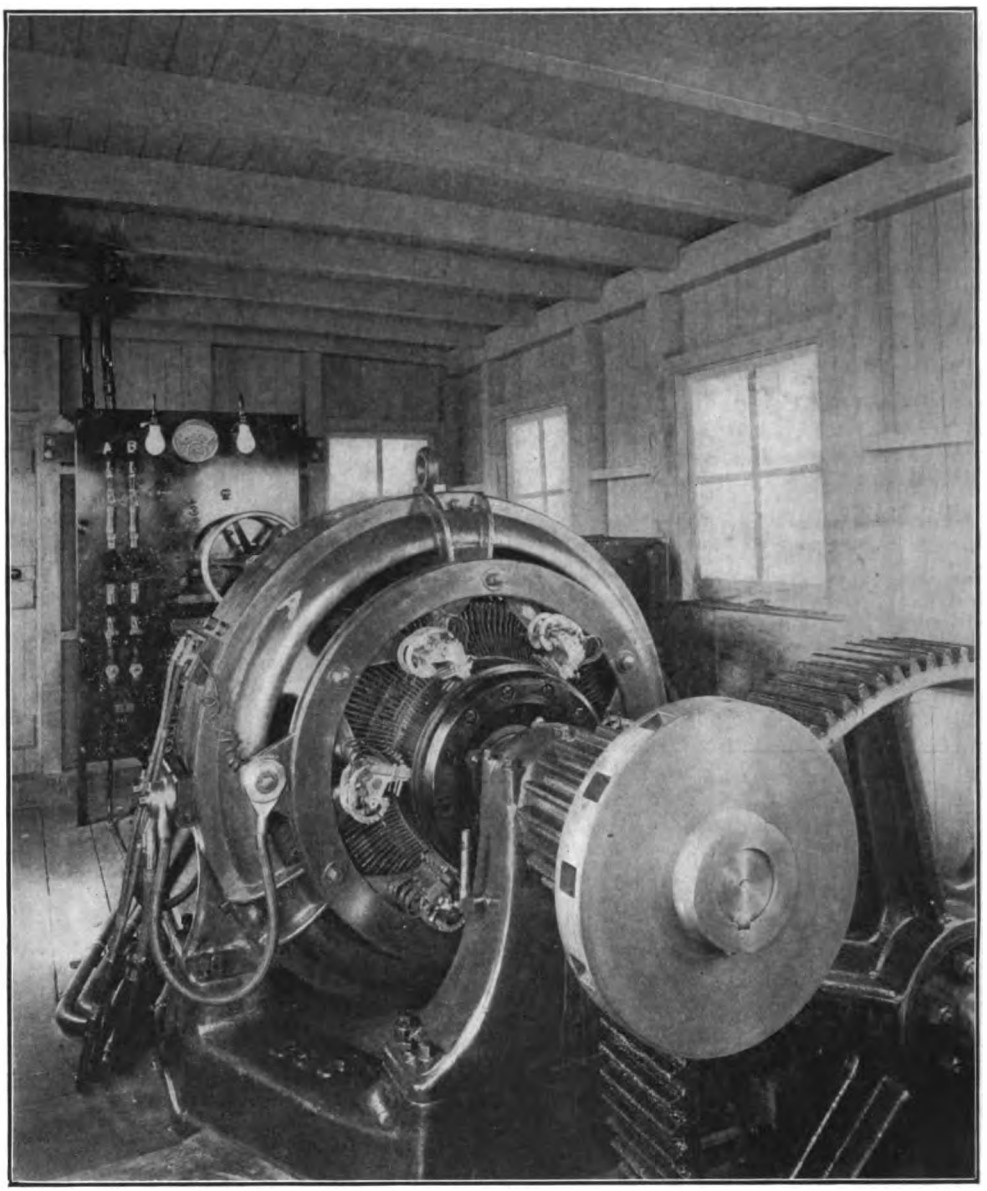

ELECTRIC MOTOR AND GEARING FOR OPERATING THE PUMPS OF A FLOATING DRY-DOCK.

minute; this is reduced by gearing to 110 revolutions of the line shaft and to 55 revolutions for the pumps, which speed will pump the full capacity of the dock, 3,000 tons, in about 35 minutes.

The motor is operated from the electric light company's mains at 240 volts; the current being led from the pier to the motor house on the dry-dock by flexible cables. The switchboard within the house is situated conveniently to the motor, as clearly shown in the photograph of interior of motor house. It is very essential in the docking of vessels to have a perfect and reliable control of the speed of the pumps, and the requirement of the contract was that the control should give at least ten different speeds, which should range from full speed down to 10 per cent. of full speed, and that the motor should operate continuously at any of the required speeds.

As the motor is necessarily exposed to salt air and moisture, thorough insulation was very carefully provided for, also the insulation of the pumping machinery (which of course is very thoroughly grounded to the water) from the frame of the motor. The installation has been an unqualified success and has now been in operation for several months without interruption of any kind. The pumping of dry-docks is a class of work for which electricity is especially adapted, as it requires a large amount of power for but a short time and at uncertain intervals and often at short notice; and where the source of electricity is available at any time of night or day, it is of especial value in case of an emergency which may require the docking of an injured vessel in the shortest possible time.

In addition to this dock the company has a dock operated by steam, 192 feet in length on keel blocks, with a capacity of 1,000 tons and a draft of 16 feet, and is also well equipped for repair work.

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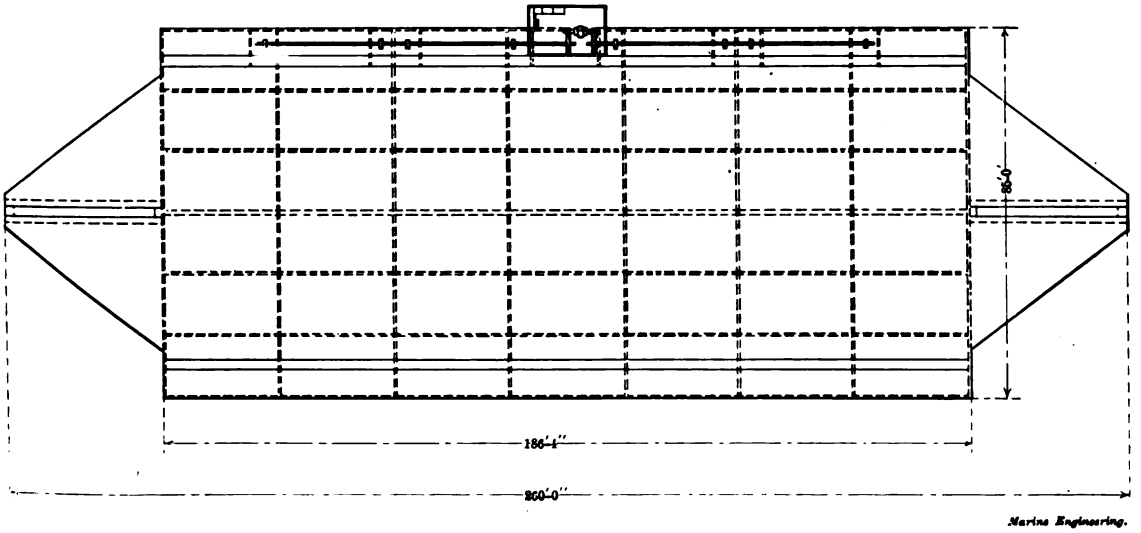

Marine Engineering.

FLOATING DRY-DOCK OF JAMES TREGARTHEN AND SONS COMPANY, ELECTRICALLY OPERATED.

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PRACTICAL MOLD WORK IN SHIPYARDS.

BY SIDNEY H. MCLANE.

While shipbuilders are purchasing improved machinery to increase the output of their shops, and naval architects are designing details that will lessen the cost of production, too little attention is given in many yards to the method of actually building the ship. The construction plans of the ship, though they may have been the subject of much careful thought with a view of reducing the cost of construction as much as possible, may be turned over to a foreman who is incompetent to judge how to turn out work in the simplest and cheapest manner. Instead he may content himself with the old way of not starting one portion of the ship until all preceding parts are in place and then proceed to template off clips, liners, plates, etc., of which a large number could be made in duplicate and laid off for one-fourth the cost, besides the advantage of having the parts ready when wanted.

Some firms attempting mold work will allow a fitter to go ahead and make his own molds for that portion of the ship given him to construct, regardless of adjacent work, which might have been laid off from molds had the foreman decided in time upon the general method of laying out the remainder of the work. Thus adjoining parts may not be started until his work is all in place. In all yards enterprising enough to desire mold work as a means of reducing the cost of construction, there should be some one whose duty it would be to look after all the molds and loft work and to have direct supervision over the men using the molds. The material laid off should be tallied daily in a systematic manner. The man in charge should qualify as a thorough loftsman and fitter and be capable of estimating closely on work, in order that he may decide what work it would be profitable and more advantageous to lay off from the loft and what work should be templated.

Often, in shipyards where the template system is used extensively, the workmen, and even foremen, will try to place obstacles in the way of introducing molds because of increased production per man without extra compensation; for, with molds, fifteen plates would be a fair day's work, against three or four by templating at day wages. For this reason it is suggested that all men using molds come under the loftsman, as he could select men from whom there would be no opposition.

As to piecework, the only difference will be a reduction in the price of plates and shapes laid off molds, while the workman still earns the same wages with no increased manual labor.

One large item of expense which should not be overlooked is that of ribbands and the fairing of the ship by carpenters, the greater portion of which is unnecessary if the ship is laid off from molds, as the plating tends to fair the ship and holds the frames to the required spacing. The wages of ten or fifteen carpenters employed at putting on ribbands and fairing the vessel would amount to thousands of dollars during the construction of a large ship, which would pay for the labor and material used on the molds for the same ship many times.

In the largest yards on the Great Lakes, where mold work is used to the greatest extent, there are only three or four men and a boy in the loft during the busiest season of the year, but the work is done systematically and is thoroughly understood. A separate mold is not made for each plate, but a single mold is so arranged that all the plates of a large bulkhead or as many as one hundred deck or shell plates may be laid off from the one mold, as will be explained in detail further on.

Mold work enables the builder to proceed simultaneously with all parts of a hull. If he were asked what the use of his building slips would be worth to him for a period of three or four months each year, he would probably state a sum well up in the thousands; but does he realize that by methods of quicker construction the capacity of his slips would be increased to that extent?

The reduced cost of riveting must also be noted in connection with this work; for many parts of the ship can be assembled on the ground and riveted by machines at a much lower cost per rivet, and at the same time have the work so much nearer completion that when the parts are assembled there remains but a small quantity of riveting to do on the ship, with the exception of the shell and deck which must be riveted in place.

Some builders might object to the use of molds owing to the amount of lumber used, but at the same time they continue to pay bills for ribband lumber large enough to pay for the molds on several boats. With molds the fitters would be using but little template wood on the ship. Even to-day there are firms who make a wooden mold for each frame for use at the bending slab, and then carry the frames and floor plates to the screiveboard and to and from the punch in order to transfer the holes in the frames to the floors and beam brackets, while by simply laying off and boring the molds the expense of carrying hundreds of tons of steel to the screiveboard, and the cost of the expensive screiveboard itself, are done away with. Another disadvantage of the screiveboard is that only one frame in each body is under way at a time, and the frames have to be set so much nearer shape than when laid off from molds, as the floor plates will pull the frame to shape.

The cost of mold-making will vary greatly, according to the system used in joining the molds and transferring the lines from the floor to the molds. Apprentice shipfitters who are to be trained in the use of molds may be sent to the loft to make the molds with the aid of a carpenter to plane them perfectly fair, and the man in charge should mark all these for boring.

Some builders will allow a longitudinal with much twist in it to be laid off from the loft development; but when it comes to laying off a flat shell or deck plate from a mold, they either do not understand the principle of a practical method or do not care to try anything new.

The order of erecting a ship with framing and shell laid off from molds would be as follows: The keel plates would be laid on the blocks and lined up by keeping the center line on the plates over the center line on the blocks; the keel liners, butt straps, keel bars, center keelson plates, and stiffeners are placed in position and well bolted together. The riveting and calking should be commenced before any floors are placed. The garboard plates are then lapped on to the keel plates, to be followed by the succeeding strakes of bottom plating to the lower turn of the bilge. The outboard strake should rest upon a ribband substantial enough to carry the weight of the frames.

Framing may be commenced by erecting five or six

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frames amidships, and the bottom plating, which has been resting on temporary shores with the exception of the outboard strake, should be bolted to the frames, the liners for the outside strakes having previously been laid in place, so that the bolting of the shell may be completed as the frames go up.

The side plating may now be commenced, starting at the top and working downward, taking care that the plates are exactly in place before being bolted up. It will not be found necessary to horn the frames, as the plating will bring the frames to the desired angle of the keel. The object in starting the plating at the deck is to keep the sheer fair. The usual method of fairing the frame with ribbands from the keel up causes the top of the frames to be unfair and necessitates templating off the beam brackets after a fair sheer line has been run on the frames, and consequently the work of placing the beams and plating the deck is retarded.

When it is inconvenient to erect frames with the beams attached, the beams should be put in place as soon as each frame is erected and secured. Starting with the deck stringers and gunwale bars, the deck plating should keep pace with the framing. The inside work, such as bulkheads, stringers, keelsons, inner-bottom plating (if any), etc., should follow the framing as closely as possible.

With mold work all lap holes in the frames and beams should be punched, as the customary drilling of these holes on a ship four hundred feet long amounts to over five hundred dollars.

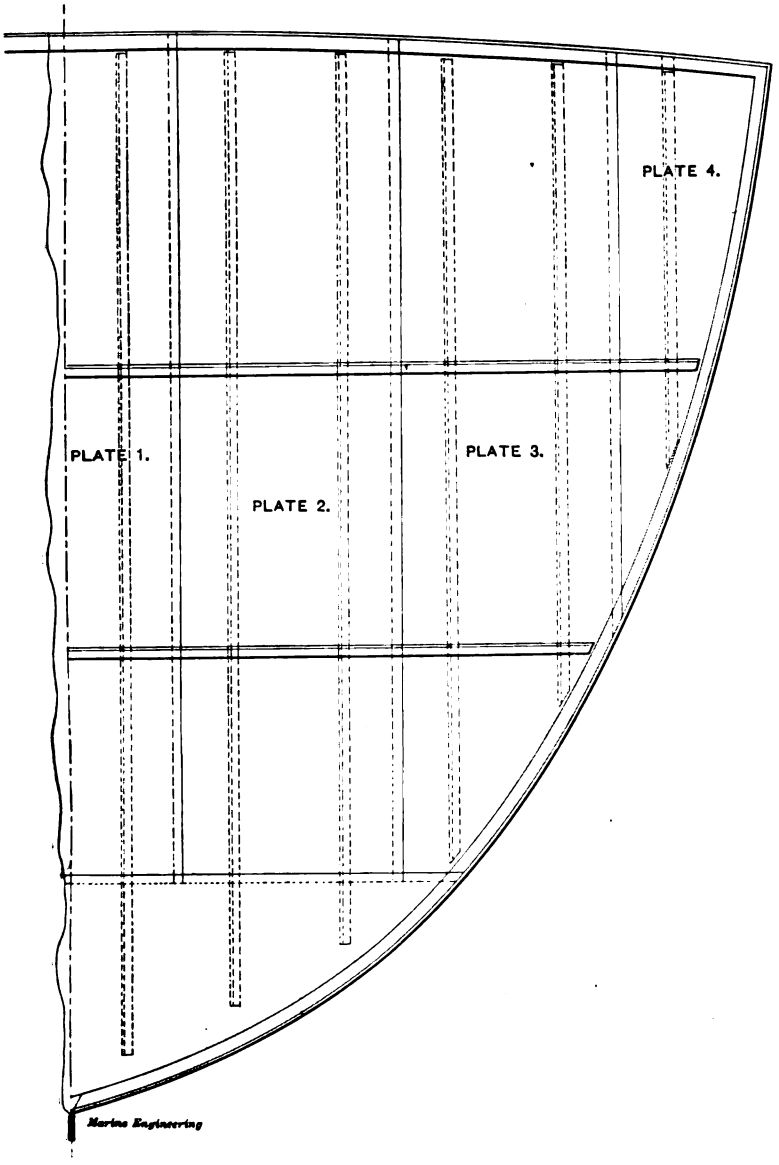

FIG. 1.

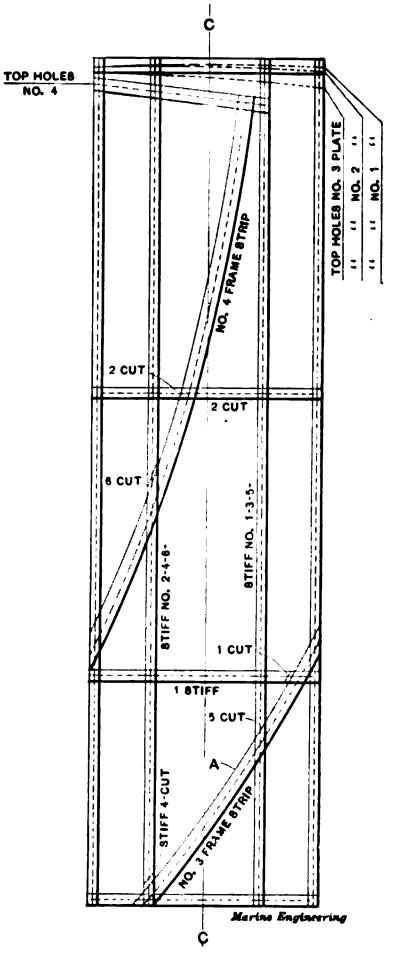

FIG. 2.

As an example of mold work we will take a small bulkhead of seven plates in width. Fig. 1 shows the general arrangement of the plating, plate No. 1 being a center plate with Nos. 2, 3, and 4 on each side. Each plate, with the exception of No. 4, is stiffened by two vertical and two transverse stiffeners.

The molds required would be as follows:

One frame and floor mold.

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One plate mold.
One vertical stiffener mold.
One horizontal stiffener mold.
One beam mold.

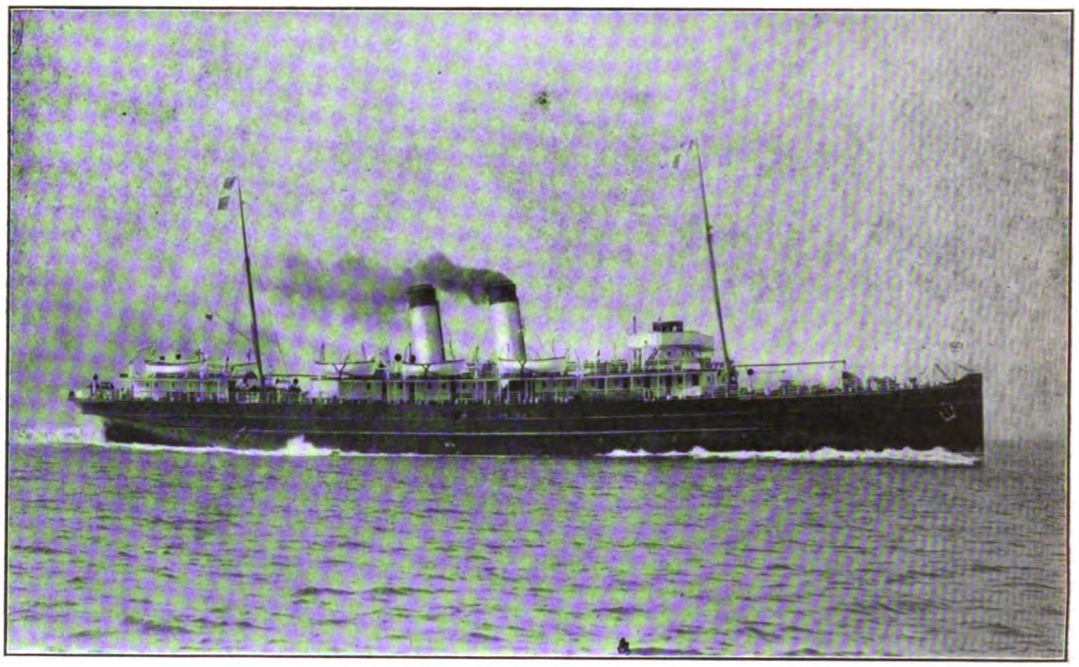
The plate mold should be made of 1-4-inch template wood with all joints lapped to the dimensions of plate No. 1, with strips nailed on to receive the stiffener holes. It is then placed on the body plan in the loft and the crown of the beam marked on the top; it is then moved outboard to the position corresponding to that of plate No. 2, care being taken to keep the mold the same height from the base line. A line struck on the floor at the height of the transverse stiffeners will serve as a guide in moving the mold outboard.

The crown of the beam on No. 2 plate is now marked across the top of the mold and the latter then shifted to the position corresponding to that of No. 3 plate. In this position the strip *A*, Fig. 2, is nailed to the mold to receive the frame holes and also to show the lower boundary line of No. 3 plate; the mold is then shifted to the position of No. 4 plate and a similar strip is nailed to it to receive the frame holes and a strip at the top for the beam holes. The holes may now be spaced and bored. At the top, where the holes come quite close to one another, they should be plainly numbered. Holes to be used on any one plate only should be marked accordingly. After the mold is bored the battens to be used in laying off the stiffeners may be marked off, care being taken to show where all the stiffeners are to be cut and numbering each cutting mark. Both sides of the mold must be marked, so that the stiffeners may be laid off in pairs.

If the bulkhead to be laid off is a large one, the holes for the deck beams should not be bored, with the exception of the top hole in the lap to serve as a guide hole. A short beam mold the width of the plate should be made, and after marking off a plate, with the exception of the beam holes, the mold is removed from the plate and the short beam mold applied, the end holes of which should correspond with the top hole in the lap; the remaining holes and shearing line may now be marked.

For a steel mast simply a seam batten and butt mold are used. For the side plating of a ship the tip-up system is used, requiring a butt mold, seam mold, and frame batten with the sheer heights marked upon it. If a strake of plating is traversed by a line of holes for a fender bar, stringer, etc., a short mold will be used for the same.

[This method of procedure in building a hull is much different from the usual practice, and we would like to hear further remarks on the subject. No mention is made of using the mold for warped surfaces.—Ed.]



NEW ENGLISH CHANNEL STEAMER QUEEN, DRIVEN BY PARSONS TURBINES.

TURBINE CHANNEL STEAMER QUEEN.

There is now running successfully on the cross-channel service of the Southeastern and Chatham Railway a new fast steamer, named the *Queen*, which is specially interesting as it is propelled by three turbines. The *Queen* was built by Messrs. Denny, of Dunbarton, and is the largest of the present fleet of turbine-propelled ships. She has a length of 310 feet, a molded breadth of 40 feet, and depth of 25 feet. There are 3 decks running fore and aft, a promenade deck carried above and extending for about two-thirds the length of the vessel. The first-class passenger accommodations are in the forward part. On the lower deck are the sleeping accommodations for the men, and the dining room; on the main deck are the ladies' accommodations; and on the upper or awning deck are several large private cabins and a smoking room. A broad, sheltered prome-

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nade space on this deck is especially appreciated by those who travel on this steamer.

The second cabin is placed aft of the machinery. The crew are accommodated on the lower deck at the stern, and the officers and engineers on the main deck amidships. Appliances for working the vessel are exceptionally powerful, and consist of a large windlass and capstan at the fore end and a warping capstan aft. The single-plate rudder is worked by Brown Brothers' steam tiller, controlled from the flying bridge by the maker's patent tiller motor. There is fitted at the bow a large rudder for convenience in backing out of the harbor; this rudder is also worked by steam-steering gear controlled by a wheel on the flying bridge.

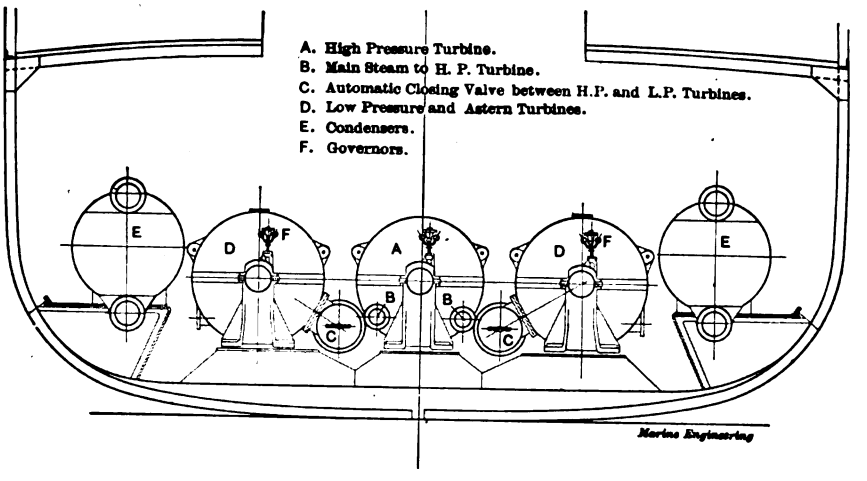
The boats are swung on special davits, which are fitted to work rapidly, and it is the intention to swing the boats out at all times, except when entering harbor or laying alongside.

The propelling machinery consists of 3 Parsons turbines—a high-pressure mounted on the central shaft, and two low-pressures mounted on wing shafts. On the central shaft, which revolves ordinarily at about 500 revolutions per minute, is placed one propeller, and on each of the outboard shafts, which ordinarily turn at 700 revolutions, is placed one propeller. It will be noted that this is a different arrangement from that first adopted with the Parsons turbine; in the former vessels two or more propellers were fitted on the outboard shafts, but experience has shown that the best results are obtained with but one propeller on each shaft. The accompanying diagram shows the cross section of the engine room of the *Queen*.

In ordinary going ahead the steam from the boilers is admitted through a regulating valve to the high-pressure turbine, and, after expanding about fivefold, it passes to each of the low-pressure turbines in parallel and is again expanded in them about twenty-five-fold, passing thence to the condenser; thus, instead of an expansion ratio of 12, as in the ordinary triple-expansion engine, it is 125 in this type of turbine. When coming alongside of the wharf, or when maneuvering, the outboard shafts only are used and steam is admitted directly to the low-pressure turbines. For going astern, special reversing turbines are fitted at the backs of the low-pressure casings, and the steam may be turned directly into them. Thus the port or starboard turbines may be worked ahead or astern and independently of each other and of the high-pressure turbine, which latter rotates idly in a vacuum under these conditions.

It is claimed that the *Queen* has exceptional maneuvering qualities; that on her trial on the Clyde, when steaming continuously astern, she attained a speed of 13 knots. Starting and stopping trials were also carried out, and the vessel when going over 19 knots was brought to a dead stop in 67 seconds after the telegraph order of reversing was given to the engine room, and the distance traveled in this time was equal to only about 2 1-2 times the vessel's length. On official trial the *Queen* attained a speed of 21.76 knots over the measured mile.

The air and circulating pumps for each low-pressure turbine are worked from one steam engine. The air pumps discharge into a float tank from which two Weir pumps supply two single-end Scotch boilers, fitted with forced draft on the closed-stokehold system. A marked difference is noticeable in this steamer from other fast vessels of the Channel fleets, in that there is practically no vibration whatever. Another innovation is that the funnels on the *Queen* are fitted with spark arresters of the Denny and Vrace type.



SECTION THROUGH ENGINE ROOM ON TURBINE STEAMER QUEEN.

At the launch of the turbine steamer *Queen Alexandria*, Mr. James Denny, in commenting upon the economy in coal consumption of turbine-propelled vessels, stated that if the *King Edward** had been fitted with balanced twin-screw triple-expansion engines of the most improved type, and of such size as would consume all the steam that the boiler could make, the best speed obtainable would be 19.7 against 20.5 knots actually obtained by the *King Edward*. The difference between these two speeds corresponds to a gain in the indicated horse power in favor of the turbine vessel of 20 per cent.

*The general description of the Parsons turbine and the *King Edward* were given in Marine Engineering for January, 1902.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

THE retirement of Rear-Admiral Melville as Chief of the Bureau of Steam Engineering, United States Navy, marks the close of a career whose influence on naval engineering in the United States during the past sixteen years has been paramount, and whose relations with the development and progress of the entire art of marine construction the world over have been wide and fruitful. In another column the reader will find a brief synopsis of Admiral Melville's official career, and we have here but to add a word of appreciation, with such representative capacity as we may, from the field in which he has labored so long and so fruitfully.

Called in 1887 to the position which he has filled with such distinction since that date, the Navy Department was just entering upon wider plans for the upbuilding of the new Navy after the relatively timid start made in 1883. At the date of his appointment Admiral Melville was well down the list of chief engineers, and, having spent most of his life at sea, had found but small opportunity for showing his capacity for office and administrative work. Secretary Whitney, who made the appointment, doubtless realized, however, that at the rate and with the direction in which the Navy was then growing, there was needed for the position of chief of the Bureau of Steam Engineering a man possessing a wise combination of engineering ability, boldness, persistence of purpose, executive capacity, independence of thought, readiness to accept responsibility, and all tempered by good judgment and common sense. These the previous magnificent record in the Arctic on the De Long expedition, and elsewhere in the service, showed Admiral Melville to possess to an unusual degree.

That the appointment justified the expectation the history of the United States Navy during the past sixteen years abundantly proves. Added to his own high qualifications as an engineer, Admiral Melville has had likewise the rare capacity of surrounding himself with a corps of able, enthusiastic, and loyal lieutenants. The result has been a grade of naval engineering which, it is not too much to say, has set the world a standard. He has thus labored unceasingly and with all his energies for the upbuilding of the Navy and for the advancement of marine engineering both as a science and as an art. He has been bold and fearless in advancing and maintaining his opinions and measures, and tireless in carrying them forward into operation.

With these characteristics and with the success which has from the first met his efforts and crowned his policies, his influence has naturally run wide and deep through the period of growth with which he has been associated. His responsibilities have been great, but he has met and borne them with patient and patriotic devotion to his ideals of duty, and, in truth, any attempt to detail the points where his influence and policy have been moving factors would mean almost a history of the development of our Navy during the past sixteen years.

Admiral Melville is still in the midst of his vigor and capacity for work, and for such a man retirement from active duties at the Navy Department will only mean a transfer of activities to some other congenial field. He retires from his active service in the Navy with the assurance of leaving behind him an imperishable record of faithful and fruitful service, with the love and admiration of his assistants and associates, and we most heartily wish for him many years yet of health and activity in some part of the field of engineering work where he has already served so long and with such high distinction.

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WE again have occasion to comment on another international yacht race for that much-prized trophy, the *America's* Cup.

Beginning with the *Genesta,* in 1885, the evolution of the cup challenger and défender from a sailing boat laid down by eye to the modern racing machine has been most radical and most rapid. Weight, which formerly was not a serious question, has now become a most important factor, second only to that of form. The construction of the modern boat has received the closest attention of specialists in many trades. Pre-eminently, of course, has come the form of the under-body, which under the racing-measurement rules for 90-footers has evolved from the cutter of the Englishman and the centerboard type on this side of the Atlantic to a long, narrow, shallow hull with immense overhang at bow and stern, and the lowest water lines dwindling into a fin with heavy lead keel at the bottom. Above deck, the mast, spars, and spread of canvas have increased enormously; the sail area of the *Puritan* was about 7,000 square feet, while *Reliance's* was over 18,000 square feet.

Given a certain length of water line, the naval architect's problem, once he has decided upon the form of hull, has been to design a boat to carry the maximum amount of sail. Displacement and sail area are the two important elements—to keep down the former and increase the latter; in other words, with a definite displacement, the greatest possible weight must be devoted to increased area of sail and making a stiff, heavy keel to hold the boat up under the sail.

On the other side of the water the combined talent of many experts has been directed to the study of these questions. Under the open purse of Lipton no expense has been spared in model experiments of many alternate designs to develop a boat that would lift the cup, while on this side Herreshoff has successively for many years been able to turn out a boat speedier than her predecessor. As was proved in the trial races this year between *Columbia, Constitution,* and *Reliance,* his claim, that if *Constitution* had been properly sailed two years ago she would have defeated *Columbia,* is verified. In his last design he profited by the experience of the Crowninshield-designed *Independence,* which was much larger in every way than either *Constitution* or *Columbia,* and proved herself to be a successful and practical type, although not a decidedly satisfactory boat. The great speed and superb sailing qualities of *Reliance* show the wisdom of the increase of 2,000 square feet of sail area over his previous designs.

The availability of the model of these great single-stickers for general yachting purposes is still a question, although at the close of the 1903 races this type seems to be in greater favor than it formerly was. The ability of Herreshoff to build the better boat, and, when once she is finished, for Captain Barr to get the most out of her, is a source of congratulation for us all. Regardless of the suitability of the type, the coming together of the yachts has been a great stimulus to the yachting profession and a means of strengthening the ties of friendship between ourselves and our cousins across the sea.

AMONG the many problems which confront both the practical and the designing engineer, few are of greater interest or perhaps of higher importance than those having relation to valve gears and steam distribution in general. With the view of helping the practical marine engineer in his study of such problems, we begin this month the publication of a series of articles by Professor W. F. Durand, and would call the attention of all who may be interested to the presentation of the matter to be given in this series. The valve gear is of importance both from an operative point of view and from the economic standpoint. Regularity and smoothness of operation, facility in stopping, starting, and handling, absence from pound and jar, all depend on the valve gear, as well as the proper point of cut-off and the general scheme of steam distribution best suited to economy of operation and maintenance. The problems connected with valve gear have long been a fruitful field both for the inventor and the practical engineer, and the number of valve gears, including minor varieties and secondary adjustments, is enormous. Of this vast collection of possibilities but few types have stood the test of practical experience, however, and the field becomes thus narrowed to the forms which have met the requirements of every-day experience under the exacting demands of advanced marine practice. With these types and their possibilities, however, the marine engineer should be fully conversant, and with a view of giving him aid in his study along these lines these articles have been prepared.

The fact that the articles are from the pen of Professor Durand will be ample guarantee as to their value.

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THE DESIGN OF MARINE MACHINERY.

BY W. F. DURAND.

Valve Gears.

[1] Simple Slide Valve and Definitions.

It is the function of the slide valve and its operating gear to bring about the following operations:

(1) The admission of the steam alternately to each end of the cylinder and the closure of such admission at a point suited to give the desired degree of expansion.

(2) The release of the steam from the cylinders when the piston is near the end of the stroke, and the closure of such release near the close of the return stroke in order to give the needed compression.

These various conditions being properly fulfilled, there results within the cylinder a smooth and continuous motion of reciprocation, which outside the cylinder is transformed into a motion of continuous rotation by the agency of the connecting rod and crank. In addition, in all

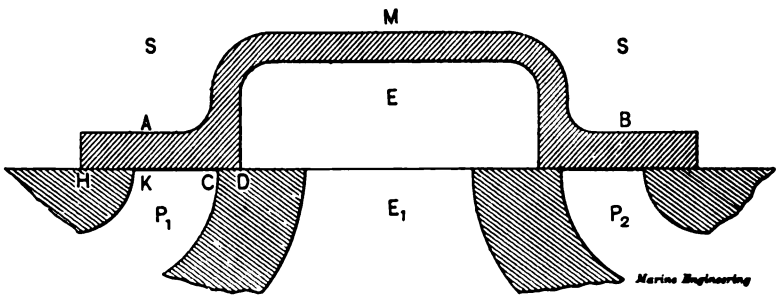

FIG. 1.—PLAIN SLIDE VALVE, MID-POSITION.

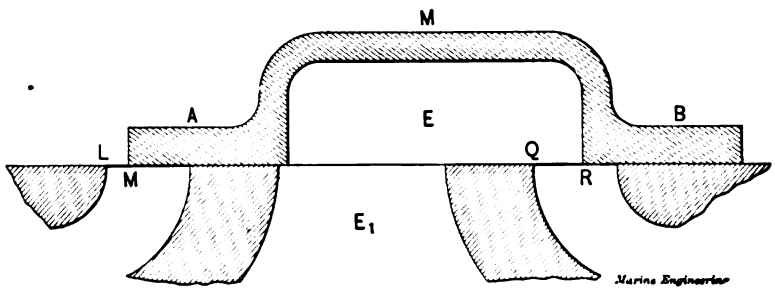

FIG. 2.—PLAIN SLIDE VALVE, POSITION FOR END OF STROKE.

reversing valve gears, the arrangement must be such that the motion of rotation may be produced at will in either direction.

Primarily, then, the valve gear must provide for four events in each end of the cylinder—steam opening and closure and exhaust opening and closure; and in all marine gears this must be under such control as to provide for operating the engine in either direction at will.

Before taking up the various forms of reversing valve gears, we shall, however, find it useful to examine the operation of a simple slide valve operated by a single eccentric.

In Fig. 1, AB represents a simple slide valve surrounded on the outside, SS, by steam, and in the position shown covering both P_1 and P_2, the passages leading to the two ends of the cylinder. The passage E_1 leads to the exhaust opening in the cylinder, and is separated from the live steam in the chest SS by the shell of the valve AMB. It may be readily seen from the diagram that if the valve AB is moved back and forth the port P_1 will be alternately placed in communication with the steam chest S and with the exhaust passage EE_1; similarly the port P_2 will be given the same connections as P_1 and alternately with it. That is, when P_1 is in communication with the steam, P_2 will for the most part be in communication with the exhaust, and *vice versa*. In a general way this is seen to fulfill the conditions above specified, and it therefore follows that if such a valve were given a reciprocating motion suitably timed

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with regard to the piston, the necessary conditions might be fulfilled. Before considering the matter in further detail, however, we must first note certain definitions.

Let us suppose in Fig. 1 that the valve is in the middle of its travel to and fro. Then the distance *HK* by which the valve overlaps the port on the steam side is called the ***steam lap.*** The distance *CD* by which the valve overlaps the port on the exhaust side is called the ***exhaust lap.*** Again, in Fig. 2, suppose we have the valve in the position occupied at the end of the stroke. Then the distance *LM* by which the valve is open for the admission of steam is known as the ***steam lead,*** and the distance *QR* by which the valve is open for exhaust is known as the ***exhaust lead.*** In general, therefore, ***lap*** is the distance by which the port is covered when the ***valve*** is at its ***mid***-stroke, while ***lead*** is the amount by which the port is open when the ***piston*** is at the ***end*** of its stroke.

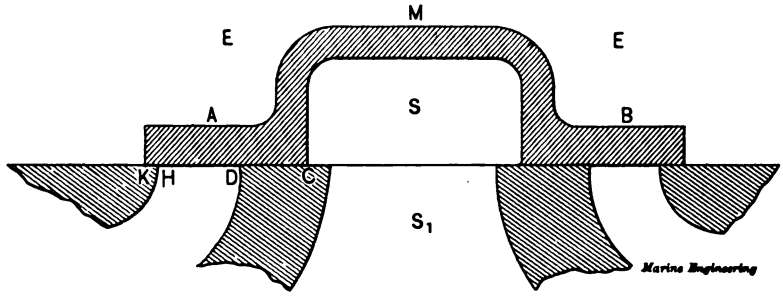

FIG. 3.—INSIDE VALVE, MID-POSITION.

[2] Outside and Inside Valves.

It is by no means necessary that the steam and exhaust sides of the valve should be related as shown in Fig. 1. It is frequently convenient to arrange the valve as in Fig. 3, in which the steam is connected with the inside and the exhaust with the outside. Such a valve

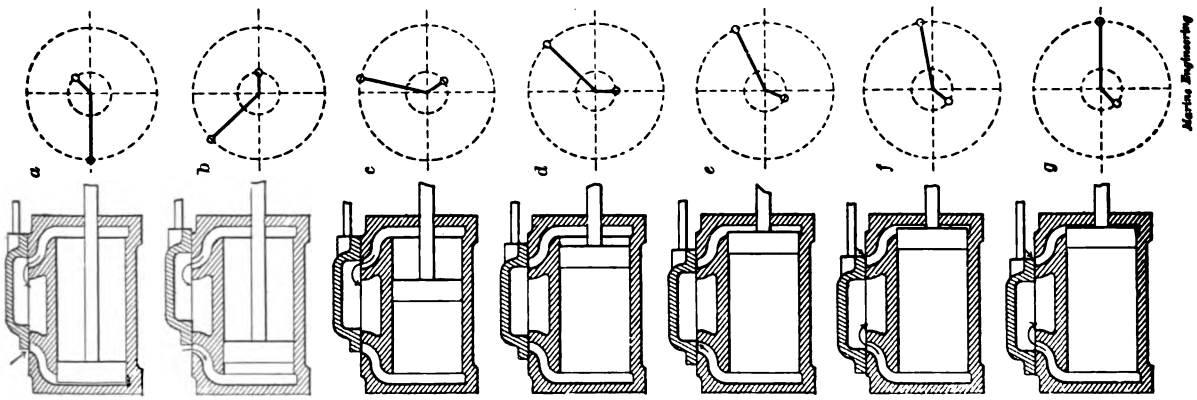

FIG. 4.—SERIES OF CRANK AND VALVE POSITIONS.

is known as an ***inside*** valve, while the more common type of Fig. 1 is known as an ***outside*** valve. The steam here enters past the inside edge of the valve *C* and the exhaust escapes past the outside edge *K*. The inside lap, *CD*, becomes, therefore, the steam lap, and the outside lap, *HK*, becomes the exhaust lap.

[3] Movement of a Simple Slide Valve.

In Fig. 4 are shown a series of corresponding positions of the valve and piston during a single stroke of the latter. The position *(a)* is the same as that of Fig. 2, and the port is open for the admission of steam on the left and for exhaust on the right. The piston is at the end of the stroke and just about to begin the stroke to the right. In *(b)* the piston has advanced about 10 per cent. of the stroke, and the valve has moved so that the port is nearly wide open. Up to this point the piston and valve have been moving in the same direction. In *(c)* the piston has advanced to about 60 per cent. of the stroke, while the valve has come back and just closed the port to the entrance of steam. This is called the point of cut-off. Between *(b)* and *(c)* the piston has been moving on, but the valve has been moving back in the opposite direction. In *(d)* the piston has moved still further on, while the valve is still

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moving to the left and has just reached the point where the exhaust opening on the right is closed. This is called the point of exhaust closure, and the operation of compressing the steam in the end of the cylinder from this point to the end of the stroke is called compression or cushion. In *(e)* the piston is still nearer the end of the stroke on the right, while the valve has moved further to the left and is just about to open the port on the left for exhaust, thus allowing the escape of the steam which entered during the early part of the stroke. In *(f)* the piston has nearly reached the end of the stroke. The exhaust opening on the left is open still wider, while the port on the right is just about to open for steam. In *(g)* the piston is at the end of the stroke, the valve has moved so as to make the steam and exhaust openings still wider, and the return stroke is about to begin. This completes the history of the stroke, and the next or return stroke follows after it with like series of events, and so on continuously.

Now, on the right in the same diagram is represented a series of positions of the crank and of an eccentric set somewhat more than 90 degrees ahead of the crank. A comparison between the positions of the piston and valve on the one hand and the crank and eccentric on the other will show that if the piston and crank were connected, and likewise the valve and eccentric, the two sets of parts would move together throughout the stroke with the relative positions as shown by the diagram. It follows, therefore, that an eccentric thus located would give to the slide valve the movements required for a proper distribution of the

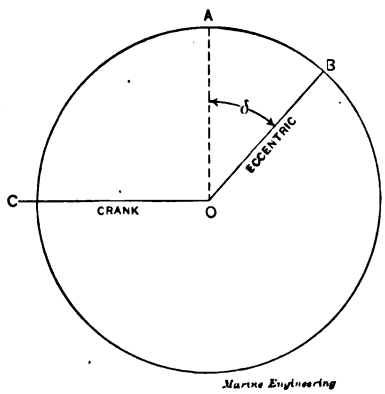

FIG. 5.—ANGULAR ADVANCE.

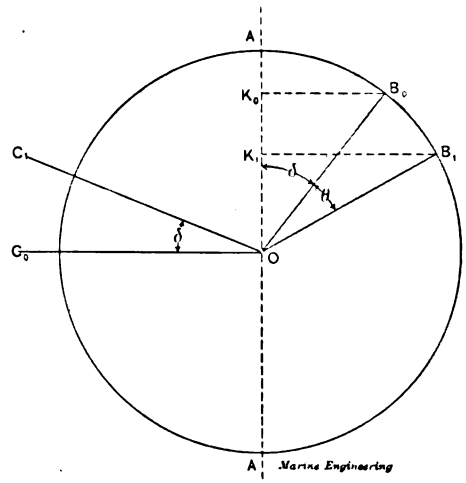

FIG. 6.—MOVEMENT OF VALVE DUE TO SIMPLE ECCENTRIC.

steam to the cylinder, as already noted. It will be seen later that among the various forms of mechanism which may be employed to give suitable motion to a valve, there is none so simple and direct as the eccentric, and, furthermore, that most of the problems connected with more complicated gears admit at least of approximate expression in terms of a simple eccentric gear. For this reason the simple eccentric gear furnishes a convenient starting point for the study of valve gears of more complicated forms, and we shall therefore consider first the elementary problems connected with this gear.

[4] Elementary Valve Gear Problems.

The quantities usually considered as entering into such problems are six in number, as follows:

Eccentric throw	denoted by r
Angular advance	" δ
Lap of valve	" L
Lead of valve	" l
Greatest port opening	" b
Point of cut-off.	

It will be noted that we take the eccentric throw as the radius of the circle described by the center of the eccentric, or as one-half the valve travel. Also, we shall take as the angular advance the angle *AOB*, Fig. 5, the excess of the angle *COB* over 90 degrees. There are, of course, various other quantities, such as the exhaust events, points of steam opening and re-

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lease, which might be considered, but it is rare that such are made the subject of a fundamental requirement, and therefore they may be left for determination after the main problem has been solved.

The relations between these various items of the problem may be shown in a great variety of ways, both geometrical and analytical.

We shall first give the analytical relation, and this will serve as a convenient standard to which we may refer various geometrical constructions. In Fig. 6 let C_0 denote the crank when the piston is at the end of the stroke, and B_0 the corresponding position of the eccentric. Let C_1 and B_1 be the like positions after revolution through an angle θ. Now, in all valve-gear problems we find it, as a rule, convenient to reckon the movement of the valve from its own mid-position as origin. To a first approximation, also, the effect of all angularities of eccentric rods, etc., is neglected, so that the movement of the valve may be taken direct from a diagram, as in Fig. 6. When the crank is at C_1, therefore, with the eccentric at B_1, the distance

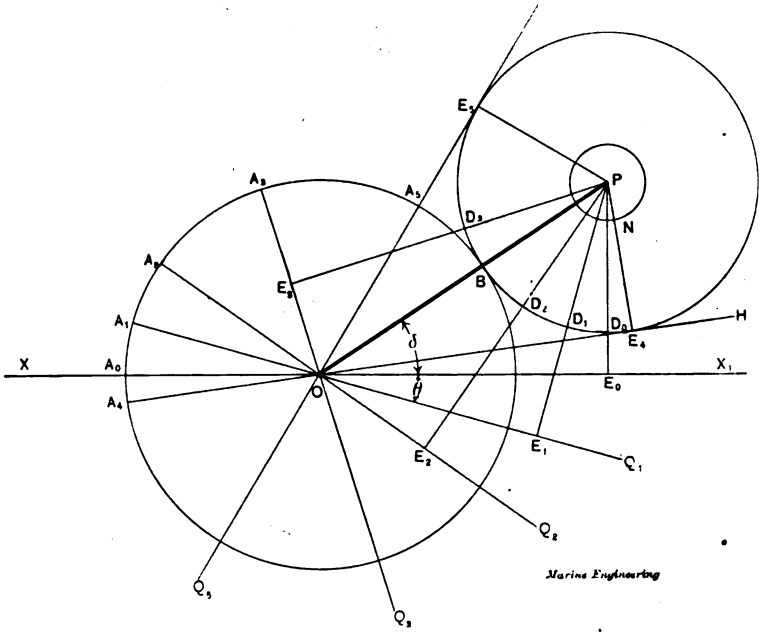

FIG. 7.—BILGRAM VALVE DIAGRAM.

which the valve will have moved from its mid-position will be shown by the line B_1K_1; and in general for any position of the eccentric the location of the valve measured from its own mid-position will be found by dropping a perpendicular from such eccentric position on the vertical AA.

Now, by trigonometry we have:

$$B_1K_1 = OB_1 \sin B_1OK_1 = OB_1 \sin (\theta + \delta).$$

In general we may denote K_1B_1, or the distance of the valve from its mid-position, by y, and we shall then have:

$$y = r \sin (\theta + \delta) \qquad (1)$$

Expanding this we have:

$$y = r \cos \delta \sin \theta + r \sin \delta \cos \theta \qquad (2)$$

Let us now denote the quantities $r \cos \delta$ and $r \sin \delta$ by P and Q, respectively. Then we have:

$$y = P \sin \theta + Q \cos \theta \qquad (3)$$

Also, $$P = OK_0 = r \cos \delta \qquad (4)$$

$$Q = K_0B_0 = r \sin \delta \qquad (5)$$

$$r = \sqrt{P^2 + Q^2}$$

then $$\tan \delta = \frac{Q}{P} \qquad (6)$$

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In particular it will be noted that in equation (3) the movement of the valve is expressed as the sum of two terms, one of which is the sine of the crank angle θ and the other the cosine of the same angle, each multiplied by a coefficient which depends on the characteristics of the valve gear alone, the values and relations of these two coefficients being shown in (4) to (7).

[5] The Bilgram Diagram.

In Fig. 7, let the line OP be laid off in length equal to the throw of the eccentric, r, and at an angle with OX_1 equal to the angular advance, δ. Then, reckoning from A_0 as the crank

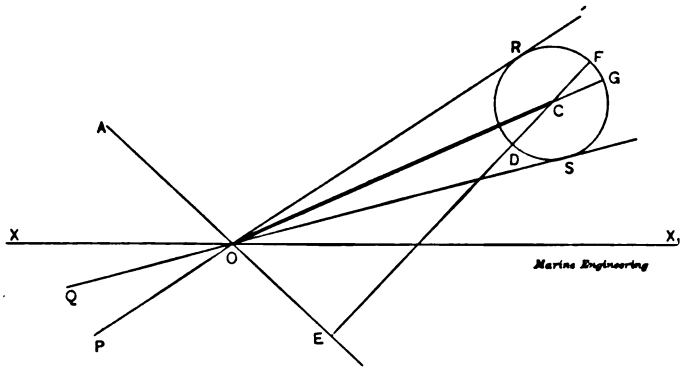

FIG. 8.—POSITIVE AND NEGATIVE EXHAUST LAP.

position for the beginning of the stroke, let any line A_1Q_1 be drawn through O, making the angle A_1OA_0 or Q_1OX_1 equal to the crank angle, θ. Then the angle $Q_1OP = (\theta + \delta)$, and by trigonometry we have:

$$PE_1 = OP \sin POE_1$$
$$\text{or } PE_1 = r \sin (\theta + \delta).$$

Comparing this with equation (1) in [4], it is seen that in the line PE_1 we have a representation of the movement of the valve from its mid-position for the position of the crank

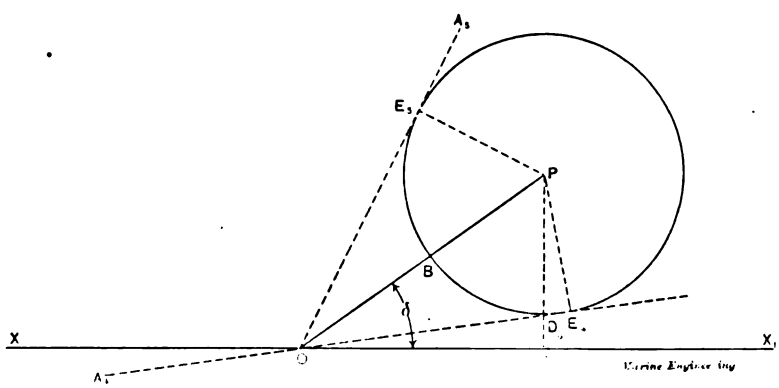

FIG. 9.—PROBLEM I WITH BILGRAM DIAGRAM.

represented by A_1, counting from A_0 as the starting point. Similarly for other positions of the crank denoted by A_2, A_3, etc., we have corresponding lines PE_2, PE_3, etc. Thus, in general, it follows that if through the point O any line AQ be drawn, making above XX on the left an angle equal to the crank angle, then a line PE drawn from P perpendicular to AQ will give by its length the movement of the valve from its mid-position.

If now we describe a circle about P with radius PD equal to the steam lap, then it follows, since the valve must move a distance equal to the lap before it begins to open, that the actual opening will be given by the distances D_1E_1, D_2E_2, etc., for the corresponding positions of the crank.

Also, since A_0 is the position of the crank for the beginning of the stroke, it follows that PE_0 is the corresponding movement of the valve, and hence D_0E_0 is the valve opening for this crank position, or, in other words, the lead of the valve.

It is also clear that lines A_4H and OA_5E_5, drawn so as to be tangent to the lap circle, will determine crank positions A_4 and A_5, for which the valve movement PE_4 and PE_5 is just equal

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to the steam lap, and hence at these positions the edge of the valve will be at the edge of the port. This means that at A_4 the valve is just opening and at A_5 just closing, or, in other words, that A_4 determines the point of steam opening or admission, and A_5 that of steam closure or cut-off.

It thus appears that in this diagram the important features of operation of the valve are indicated as follows:

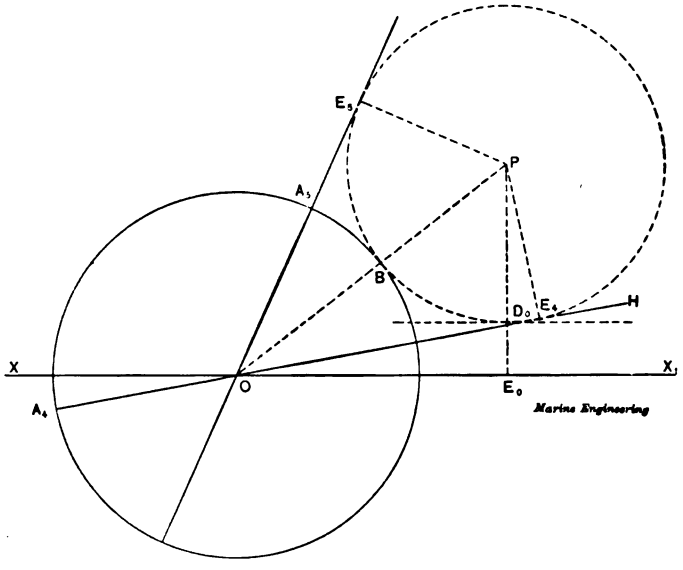

FIG. 10.—PROBLEM 2 WITH BILGRAM DIAGRAM.

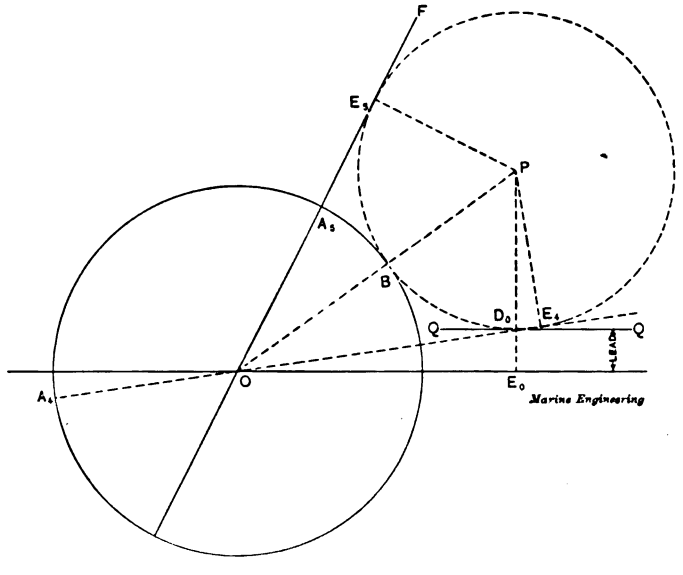

FIG. 11.—PROBLEM 3 WITH BILGRAM DIAGRAM.

Location of crank: OA_0, OA_1, OA_2, etc., reckoned from OA_0 as position at beginning of stroke.

Crank angle θ: Any angle A_0OA_1, A_0OA_2, etc.

Throw of eccentric: Distance OP.

Angular advance δ: Angle POX_1.

Movement of the valve from mid-position: Any line PE_0, PE_1, etc., determined by dropping a perpendicular from P on the line denoting corresponding crank position.

Steam lap: PD, radius of circle about P as center.

Port opening: Any distance D_0E_0, D_1E_1, D_2E_2, etc.

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Greatest port opening: OB.

Steam lead: Distance D_0E_0, determined by drawing PE_0 perpendicular to XX_1.

Point of steam opening: Crank at A_4, determined by drawing line HOA_4 tangent to lap circle.

Point of steam closure: Crank at A_5, determined by drawing line OA_5E_5 tangent to lap circle.

In the discussion thus far we have assumed that PD, the radius of the lap circle, represents the steam lap, and the various items of operation thus refer to the steam or inlet side of the valve. The construction for the exhaust items is exactly similar, and we may on the same diagram draw an exhaust lap circle with radius equal to the exhaust lap, as shown by the small circle with PN as radius. The methods of construction and representation for the various exhaust items are then exactly the same as for the steam items already discussed.

It sometimes happens that the lap on the exhaust side of the valve is cut down so that when the valve is in mid-position the port is already open a certain amount to exhaust. This distance is known as *negative* exhaust lap. In the diagram for such a case the construction is exactly the same as for positive lap, except that we must consider the sides of the circle as inter-

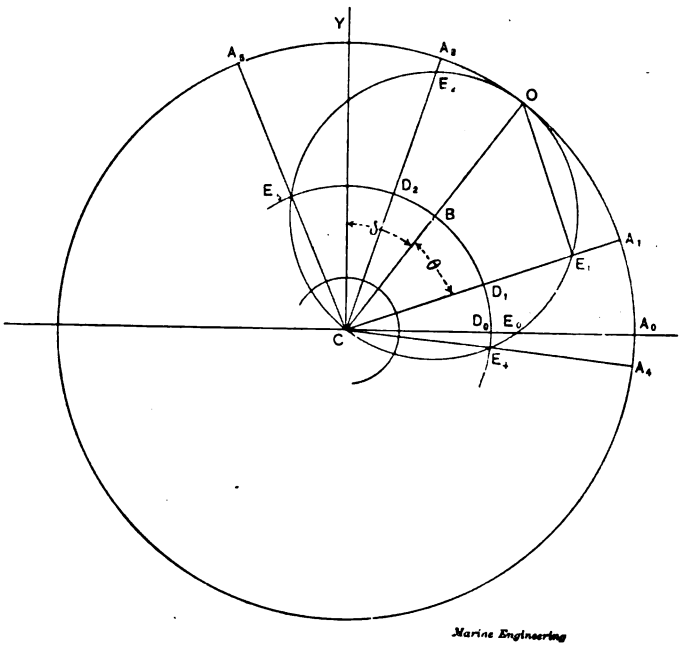

FIG. 12.—ZEUNER VALVE DIAGRAM.

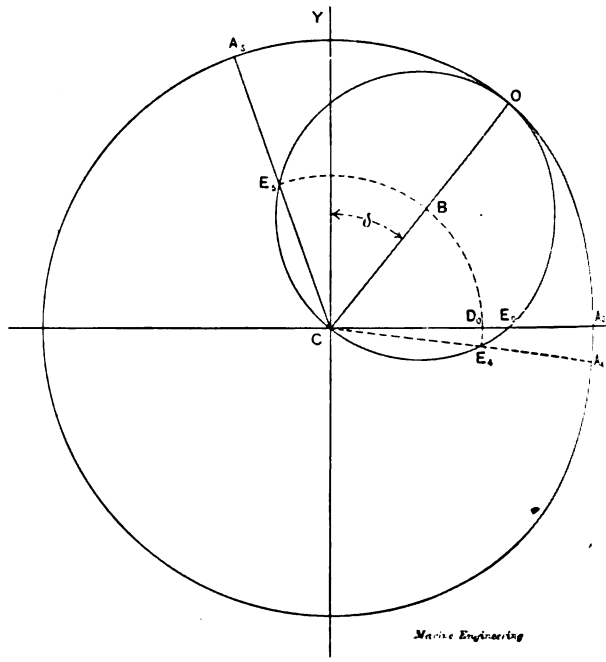

FIG. 13.—PROBLEM I WITH ZEUNER DIAGRAM.

changed and add the radius to the movement of the valve in order to find the port opening, instead of substract it. This is illustrated in Fig. 8. If the small circle about P as center represents positive lap, then the port opens to exhaust with crank in position OQ, while it closes with crank in position OR; that is, S is on the opening side of the circle and R on the closure side. If, however, the same circle represents negative lap, then R becomes the opening side and S the closure side, and exhaust opening will occur with crank in position OP and close with crank in position OS. Likewise the port opening for crank in any position OA will be DE for positive lap and FE for negative lap.

[6] Problems.

In all valve-gear problems as presented, a certain number of the preceding items are given and thus a part of the diagram becomes known. It is then required to find by geometrical construction the remainder of the diagram and the remaining items of the problem. Two or three of the more common problems will serve as examples of the method of procedure.

Problem 1: Given throw and angular advance of eccentric and the steam lap, required other items.

In the diagram of Fig. 9 this gives the items shown in the full lines. The remainder of the diagram is readily drawn in as shown by dotted lines, and the crank positions A_4, A_5, for

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steam opening and closure, the amount of lead, D_0E_0, and greatest port opening, OB, are readily found.

Problem 2: Given points of steam opening and closure and the port opening OB, required other items. This gives the full lines of the diagram in Fig. 10, and it only remains to bisect the angle HOF and find by trial a circle tangent to the lines HO and OF and to the port opening circle about O as center. The remaining items are then determined as already explained.

Problem 3: Given point of steam closure, lead and port opening OB, required other items. This is the usual problem of valve-gear design. The lead fixes a line PQ, Fig. 11, and the other given items fix the full line part of the diagram. It is then only necessary to find by trial a circle tangent to PQ, to OF, and to the port opening circle. This completes the diagram and gives the various remaining items, as above explained.

Various other problems may be solved in a similar manner, and a very little study will serve to determine the necessary construction, once a sufficient amount of data is provided to make the problem definite.

[7] Zeuner Diagram.

In Fig. 12, let the line CO be laid off in length equal to the throw of eccentric and making the angle OCY equal to the angular advance. Then let A_0 denote the initial position of the crank and A_1 any other position making an angle θ with CA_0. Then, with the construction shown, we have by trigonometry:

$$CE_1 = CO \cos OCA_1 = CO \sin (YCO + A_1CA_0)$$
$$\text{or } CE_1 = r \sin (\theta + \delta).$$

It thus appears that CE_1, constructed as shown, gives the movement of the valve from mid-position for any location of the crank A_1. If, then, we describe about C a circle with radius CD_1 equal to the lap, the line D_1E_1, in a similar manner as in the Bilgram diagram, will represent the port opening.

A little study of the diagram will serve to show that the various items of the operation of the valve are here represented as follows:

Location of crank: CA_1, CA_2, etc., reckoned from CA_0 as position at beginning of stroke.

Crank angle θ: Any angle A_0CA_1, A_0CA_2, etc.

Throw of eccentric: Distance CO.

Angular advance δ: Angle YCO.

Movement of valve from mid-position: Any line CE_1 as a part of CA_1 representing the corresponding position of the crank.

Steam lap: Distance CD, radius of lap circle D_1D_2, etc.

Port opening: Any distance D_1E_1, D_2E_2, etc.

Greatest port opening: Length OB.

Steam lead: Length D_0E_0.

Point of steam opening: A_4, determined by drawing CA_4 from C through intersection of the two circles as shown, and with reference to A_0 as beginning of stroke.

Point of steam closure: A_3, determined by drawing CA_3 from C through intersection of two circles as shown, and with reference to A_0 as beginning of stroke.

On the exhaust side it is only necessary to draw the smaller exhaust lap circle, as shown, and proceed in exactly the same manner as for the steam side. The necessary changes in interpretation to provide for negative exhaust lap are also entirely similar to those in the case of the Bilgram diagram and will need no further explanation.

[8] Problems.

The solution of problems by the Zeuner diagram is carried out in the same general manner as already described for the Bilgram diagram.

The given quantities are represented as above specified, the remainder of the diagram completed in the simplest manner available and the desired quantities thus found.

For problem 3, however, as specified under the Bilgram diagram, the construction is very complicated, and this form of diagram can hardly be recommended for the solution of this particular problem. A single example will be sufficient to illustrate the use of the diagram.

Example 1: Given the throw of eccentric, point of cut-off and angular advance, required the remaining items.

The full-line part of the diagram is readily constructed as in Fig. 13, and the dotted part is then filled in, fixing the point of steam opening, the steam lap, steam lead, and port opening as shown.

(To be continued.)

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QUERIES AND ANSWERS.

Q. 164.—Will you please advise me how to lay out a propeller blade so as to make a working drawing? F. C. S.

A.—The working drawing of a propeller blade must give the following information:

(1) The chief dimensions.
(2) The area and contour of the blade.
(3) The law of the pitch.
(4) The distribution of the thickness.

Assuming for simplicity that the pitch is uniform and the blade symmetrical and at right angles with the axis, the information needed in order to either make a pattern or sweep up the blade in loam may be laid out as shown in Fig. 1.

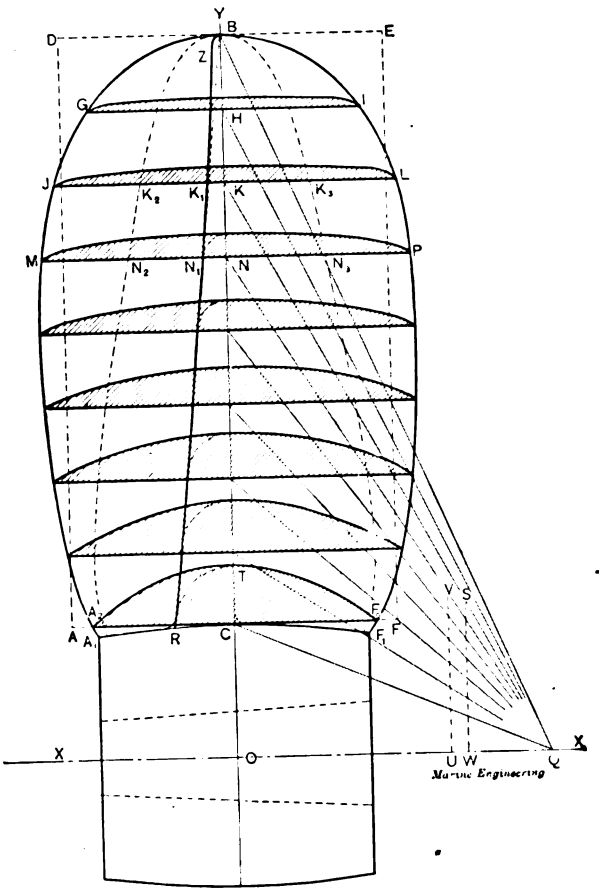

FIG. 1

Let XX be the axis of the shaft and OY a perpendicular. On OY take OB equal to the radius of the propeller. The hub may then be laid off as shown. The blade area in square feet is supposed to be known as part of the initial data. Knowing this and the actual length of blade CB, we may readily find the average width of blade. A rectangle, $ADEF$, may then be laid off as a general guide. Aided by this rectangle, we may then sketch in the actual contour of the developed area A_1MBPF_1, making it of such form as may be desired, and endeavoring by judgment to bring out the area the same as that of the rectangle. This area may then be checked by planimeter or by some of the modes of approximate computation, and the contour thus corrected until it satisfies requirements as regards both form and area. It may be here noted that for an oval blade the width at the root A_1F_1 may be taken from .8 to .9 of the maximum width.

We then divide the length of the blade CB into any convenient number of parts and draw lines across as shown. Then the widths GI, JL, MP, etc., are taken as the widths across the developed blade area at the corresponding distances from the axis. We next divide the value of the pitch by 6.2832 (the value of 2π), and lay off the quotient along the axis, as shown by OQ. That is, a length OQ is taken equal to pitch $\div 2\pi$. If then lines are drawn from Q to B, H, K, N, etc., the angles made between these lines and the radius OB will give at each point, B, H, K, etc., the slope of the surface relative to a transverse plane. That is, the angles QBO, QHO, QKO, etc., are the angles between the base and the hypothenuse of a series of guide irons, each of which, if cut to this angle, bent to the proper radius, and put in position, would lie with its face BQ, HQ, KQ, etc., in the helicoidal surface of the blade desired. These lines will therefore enable the pattern maker or molder to make such guides as may be desired in order to determine the surface required.

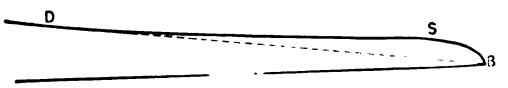

FIG. 2

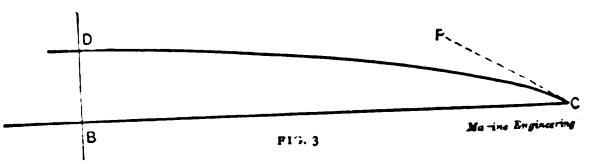

FIG. 3

We have next to specify the thickness of layout. To this end we lay off CR, the thickness at the root, and draw a straight line, RB. This would give a layout of middle thickness but for the fact that at the tip B it would be too sharp and fine for good casting. The thickness at the tip is therefore modified as shown in Fig. 2. A curve, BS, is laid in, giving the minimum thickness which can be cast with the material to be employed and which may seem suitable for the size of the propeller in hand. Such minimum thickness is usually from 1-4 to 1-2 inch. An easy reverse curve, SD, is then run from S to the line BD, and the line BZK_1R, Fig. 1, is then taken as giving the layout of middle thickness, while the area $CBZK_1R$ may be considered as a middle longitudinal blade section.

With radius CR an arc is then struck cutting OB in T. A circular arc is then struck through the points A_2, T, and F_2, and the section A_2TF_2 is taken as the blade section at the root. The actual junction of the blade with the hub is later modified by the usual generous fillet. In the same manner the other blade sections are run in until the outer sections, such as JL or GI, are reached. Here the edges would be too thin for good casting if the thickness were laid out as described, and a modification is necessary. In Fig. 3 let BD be the thickness at the middle. Then at C, the edge of the blade, lay off a line. CF, at the least angle for good casting. This will vary

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from 6 or 8 degrees for the best bronze to 20 degrees or more for cast-iron. A smooth curve, *DC*, is then run in tangent at *C* to the line *CF*, and at *D* parallel to *BC*. This method will give a suitable blade section for the outer parts of the blade.

This completes the information needed to determine the blade and make either a pattern or mold in the foundry, as may be desired. Many special variations from this simple form of propeller may be met with, each requiring some modification in the details of the mode of laying down. Space forbids a detailed consideration of these points, but the principles involved are in all cases similar to those here discussed.

It will be noted that in this method of laying down a propeller blade the projected views of the blade are not referred to or used. Such views are, as a matter of fact, of little or no value in the practical operation of making a propeller pattern or sweeping up a mold in the foundry. The information actually needed by the pattern maker or molder is that given in Fig. 1, and with such information given in this form the pattern or the mold may be readily made without reference to the transverse and longitudinal projections.

In order to examine the question of clearance between blade and stern post or rudder, however, it may be desired to determine the projection on a longitudinal plane. To this end we may proceed as follows: On *QK* lay off *QS* equal to the half width *JK*, and drop the perpendicular *SW*. Then the distance *QW* is the projected half width, and this is laid off as KK_2, KK_3. Other points are found in a similar manner, and we may thus determine the projected view as shown by dotted lines.

Q. 166.—Will you please answer in your Queries and Answers column the following:

(a) Can time made as foreman or engineer in a stationary plant be counted on in application for a marine engineer's license?

(b) Will you please give a synopsis of the rules and requirements covering obtaining licenses?

(c) Where can I obtain a copy of the United States laws concerning marine-engineer licenses? B. D.

A.—The time served as a stationary engineer cannot be substituted for the required sea service in obtaining a marine engineer's license.

The answer to the second and third inquiries may be embraced in one. Copies of the Rules and Regulations and the application for licenses of engineers for the Lakes, seaboard, or western river service, issued by the Board of Supervising Inspectors of Steamboats, may be had by writing your local United States inspector or by writing to the Supervising Inspector-General, Steamboat Inspection Service, Department of Commerce and Labor, Washington, D. C. The kind of license depends on the size of the steamer the applicant has had experience on, and whether such steamer has run in the harbors, sounds, coast, or transatlantic service. Previous marine experience is always required. Besides this, a general knowledge of the character and operation of engine, boilers, and auxiliaries must be possessed by the candidate in order for him to successfully pass an examination. Full particulars may be had by writing to the local or supervising inspectors.

Q. 167.—In a catalogue of a well-known marine engine builder the following data for a 16 and 30-inch by 18-inch compound condensing engine are given:

Revolutions	210
I. H. P.	640
Initial steam pressure	150 pounds
Cut-off	1-3
Cranks	180 degrees

Will you please show me how these sizes of cylinders are determined for this power? I should say that the diameter was too small and the cut-off was rather smaller than good practice.

Is there any fixed practice in regard to the diameter of piston valves? W. D. R.

A.—To determine the sizes of the cylinders for a 640 I. H. P. compound engine under the conditions stated, the first step will be to estimate the probable mean effective pressure reduced to the low-pressure piston area. Cut-off at one-third stroke is earlier than is common in marine practice, and earlier than can be readily realized with the usual types of marine valve gears. At the most it is not likely that more than two expansions can be obtained so far as the high-pressure cylinder alone is concerned. The assumed ratio between the two piston areas is 3.51 to 1, and this with an expansion of 2 to 1 in the H. P. cylinder would give the expansion ratio of 7 in all. By the usual formula we find that for such an expansion ratio the mean forward pressure is about 69 pounds absolute, assuming no loss between the cylinders and no rounding off at the corners, etc. Taking 3 pounds back pressure, this would give an ideal mean effective of 66. With a good compound, somewhere about 70 to 75 per cent. of this may actually be realized. This would give a probable actual mean effective of about 47.5 pounds. We then take the horse-power formula,

$$\text{I. H. P.} = \frac{2\,pLAN}{33{,}000}$$

and put it in the form:

$$A = \frac{33{,}000 \times \text{I. H. P.}}{2\,pLN}$$

Substituting the values for this case, we have

$$A = \frac{33{,}000 \times 640}{2 \times 47.5 \times 1.5 \times 210} = 706$$

The nearest even diameter for this area is 30 inches, as specified for the engine referred to. Next, taking this area, we divide by 3.51, the ratio between the L. P. and H. P. piston areas, and find 201 for the H. P. area. The corresponding diameter is 16 inches, as noted. Had some other ratio between the piston areas been assumed at the start, or a somewhat smaller expansion in the H. P., as is more probable, the details of the design would work out differently and in accordance with the conditions assumed. With steam at 150 pounds gauge and a propeller which will allow 210 revolutions, there should be no trouble in realizing 640 I. H. P. with the engine as specified.

On the H. P. cylinder the diameter of the piston valve is very commonly made about one-half that of the cylinder itself. There is, however, no hard-and-fast rule. Where the valves are used, as is sometimes the case, on the intermediate cylinder of a triple or the low-pressure cylinder of a compound, each is made, if possible, of the same size as that on the H. P. cylinder. This is more easily done with the intermediate cylinder of a triple than with the low of a compound. In the latter case the diameter for the H. P. may be made about one-half the cylinder diameter, while for the L. P. two valves

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may be used, each from one-third to three-eighths the diameter of the L. P. cylinder. These various ratios and sizes are intended to keep the values of the valve travel somewhere near the same, and thus to keep the throw of eccentric and other parts of the valve gear as nearly the same as possible.

Q. 169.—I have a 6 1-2-feet diameter by 10-foot Scotch marine boiler that seems to be a little slow in making the steam we think it should do on natural draft. It has a 7-foot 11-inch by 35-inch furnace; 151 2 1-2-inch by 7-foot 11-inch tubes; combustion chamber is about 23 inches between after tube sheet and water back. The smokestack is 28 1-2 inches diameter by 20 feet long. The boiler is allowed 150 pounds steam, but we only get 120 pounds, 130 pounds ordinary running.

Firwood is the fuel used, and we get better results without grates or bridge wall. All of the Scotch and Clyde boilers out here, in which wood is the fuel, use no grates, sufficient air coming in around the wood for good combustion. On our particular boiler I have experimented with a bridge wall raised to different heights in the furnace, but find the boiler steams better without than with one. As the wood burns out faster at the front end than at the back end of furnace, I have put in a 3-inch by 8-foot gas-pipe to carry air back to the rear end to help combustion there, but cannot see that this scheme has made any noticeable difference. The draft seems sluggish, although there is a fair rush of air going through the furnace when the dampers are open. With a brisk wind striking the vessel on the forward quarters the boiler will make steam and keep the safety valve lifting.

The feed water enters the boiler at the bottom, front end, through 1 1-2-inch feed. There are no inside distributing pipes to cause the feed to cover a larger area. Several good engineers have told me that a top feed issuing through small holes in a pipe lying close above the tubes would show much better results in maintaining steam pressure. It may be that the circulation in my boiler is poor. I have thought sometimes that it might be a gain to fit one of these patent circulators worked on the injector principle and thus relieve any possibility of poor circulation; but on a small boiler like mine I do not know whether there would be much net gain in better steaming qualities, after considering the amount of steam such a device would require to operate it. I have thought about adding 8 feet more of smokestack, and this change would probably be as practical, and certain to improve the steaming, as any, but it will surely destroy the symmetry and nice appearance of the steamer, and I have hesitated long on this account. What do you think about the proportions of my boiler for good steaming results, also the top-feed and the forced-circulation schemes? Engine is 10 and 20 inches by 16 inches, compound condensing, running at 136 to 140 R. P. M., cut-off probably 5-8 anyway; duplex boiler feed pumps 4 1-2 by 2 3-4 by 4 inches at 58-60 strokes per minute; independent circulation 4 1-2 by 6 inches at 280 R. P. M. I have thought some of cutting out this duplex boiler "robber" and substituting a line pump having a short stroke, say 4 1-2 inches, but do not know how large a plunger to order.

A. H. C.

A.—Your boiler seems to be in fair proportion, and the trouble with steaming is probably due to the special conditions under which it is operated. The funnel seems to be rather short for good draft, and you could most certainly improve matters by adding the 8-foot section to which you refer. Then, again, special care should be taken to make sure that the air has free access to the furnace from the outside. You do not describe how the boilers are enclosed, but there will be no use in adding to the funnel or in trying to improve the combustion without making sure that a full supply of air can gain easy access to the furnace. The admission of the feed at the bottom in the way you describe is also poor practice, and the change which has been recommended by other engineers would surely improve the circulation. You would do much better to change the feed pipe than to install any special circulating device.

The policy of substituting a connected pump for the duplex boiler feeder may be questioned. Less steam would certainly be required, but you would lose the convenience of independent operation, and, furthermore, the revolutions of the main engine are a little high for the best results with an attached pump. Should you decide to make this change, however, a single plunger, about 3 1-2 or 4 inches diameter and 4 1-2 inches stroke, would probably be found ample for the purpose.

Q. 170.—Will you please tell me how to plot the distance the link swings and also how to lay out the oval diagram which takes in the angularity of the connecting rod? I know about the Zeuner diagram. F. W.

A.—The series of articles now being published in Marine Engineering and treating of valve gears and valve-gear problems will give information on the points referred to in your question.

LAUNCHES.

Schooner Yacht Vergemere.—On July 28 the auxiliary schooner yacht *Vergemere* was successfully launched from the yard of the Harlan and Hollingsworth Company, Wilmington, Del. Her principal dimensions are: length over all, 160 feet, on water line, 120 feet; beam, 28 feet; depth, 16 feet. She was designed by Messrs. Cary Smith and Barbey for Mr. A. C. Bostwick. All her deck fittings are of teak; the saloon is about 16 feet long and is finished in white with mahogany furniture and doors. The engine room takes up only about 9 feet by 16 feet, leaving ample room for state rooms on either side. The stack is telescopic in design.

Three-masted Schooner Yacht Atlantic.—At noon on July 29 there was launched at the Townsend and Downey shipyard, Shooter's Island, N. Y., the largest three-masted auxiliary schooner yacht ever built in America. She was christened the *Atlantic*, and measures 185 feet over all, and her beam is 29 feet. She is fitted with triple-expansion engines of 350 horse power, and has a sail area of 16,000 square feet. There are accommodations for the owner and 18 guests and it is intended to carry a crew of 35 officers and men. The *Atlantic* was designed by Messrs. Gardner and Cox.

Steamer San Jacinto.—A fine new steamer of the Mallory Line was launched on August 22 from the Delaware River Iron Shipbuilding and Engine Works, at Chester, Pa., and christened *San Jacinto*. With the exception of a ship of the Ocean Steamship Company, the *City of Savannah*, the new ship is the only steamer in the Atlantic coastwise trade fitted with twin screws. The ship is 404 feet in length over all, 53 feet 2 inches beam, and 34 feet 1 inch in depth, and the gross tonnage is given at about 5,500 tons, with storage capacity under decks of 330,000 cubic feet, equal to, say, 11,000 bales of cotton. She is designed for carrying 3,500 tons dead weight on a mean draft of 19 feet. The vessel is to be driven by two sets of triple-expansion engines with cylinders 27, 44, and 70 inches in diameter with a common stroke of 42 inches. Steam is supplied by three double-end and two single-end boilers working under natural draft and at 180 pounds pressure. The vessel was built under rules of the United States Standard Register of Shipping. Special facilities for rapidly handling cargo are provided. Accommodations for first- and third-class passengers are fitted on the upper and hurricane decks.

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Cruiser Pennsylvania.—On August 25 the U. S. cruiser *Pennsylvania* was launched from the Kensington yard of the William Cramp and Sons Ship and Engine Building Company. The general dimensions of the *Pennsylvania* are as follows: length on load water line, 502 feet; beam, extreme, 70 feet; trial displacement, 13,800 tons; mean draft at trial displacement, about 24 feet 6 inches; load draft, 26 feet 6 inches. The ship will be propelled by twin screws driven by four-cylinder, triple-expansion engines of 23,000 horse power, the diameters of the cylinders being 38 1-2, 63 1-2, 74, and 74 inches by 48 inches stroke. Steam is supplied at 250 pounds pressure by 32 Niclausse boilers with a total grate surface of about 1,600 square feet and a total heating surface of about 70,000 square feet. The contract speed of the cruiser is 22 knots. The armament for this type of vessel is very heavy and consists of four 8-inch guns, mounted in pairs in balanced turrets on the center line, one forward and one aft. On the upper deck, at the corners of the superstructure, there are four 6-inch guns mounted in sponsons, one in each corner, while on the gun deck there are ten 6-inch guns, five arranged on each broadside. The secondary battery consists of eighteen 3-inch breech-loading rifles, twelve 3-pounders, two machine guns, and six automatic guns. There are two submarine torpedo tubes placed in a compartment forward for discharging 18-inch Whitehead torpedoes. The armor protection consists of a water-line belt, 7 feet 6 inches in width, extending for a distance of 244 feet amidships. The thickness is 6 inches at the top and 5 inches at the bottom. Protection is carried to the stem and stern by 3 1-2-inch side armor. From the top of the water-line belt to the main deck a 5-inch belt is worked in, and at the end of this armor 4-inch bulkheads are worked in athwartships. The ten 6-inch guns of the broadside battery are placed behind this armor. The turrets for the 8-inch guns are 6 inches in thickness and mounted in barbettes of the same thickness. The four 6-inch guns are mounted behind 5-inch armor. The conning tower is 9 inches in thickness. A complete oil-tempered and annealed nickel-steel protective deck, 1 1-2 inches thick on the flat and 4 inches thick on the sloping side, extends the entire length of the vessel, and behind this, from end to end, a cofferdam bulkhead filled with cellulose is built in. Large magazines are provided to carry abundant ammunition for all sizes of guns. The coal bunker capacity is 2,000 tons. Electricity is extensively used for operating the turrets and for many auxiliaries. The *Pennsylvania* is fitted as a flagship. The full complement of men numbers 822.

PERSONALS.

Nicholas C. Cushing, who was formerly with the New York Shipbuilding Company, has accepted a position in the brokerage department of Cary Smith and Barbey, naval architects, 90 Wall street, New York, N. Y.

Henrick Greger Pedersen, who formerly held a position as pump draftsman with the George F. Blake Manufacturing Company, is now with the B. F. Sturtevant Company as engine draftsman.

L. B. Bradford, having finished a special course in naval architecture at the University of Michigan, has accepted a position in the hull department of the Fore River Ship and Engine Company.

ENGINEERING SPECIALTIES.

Clocks for Shipboard Use.

The necessity of a good clock for use on board ship, whether in the pilot house, saloons, or engine room, is recognized by all; for the ordinary land clock is not well adapted to the hard service required of the marine clock, which must be damp- and dust-proof, and capable of accurate running regardless of the vibrations on board ship.

The clocks made by the Chelsea Clock Company, 16 State street, Boston, Mass., meet these requirements. They keep excellent time, and, with reasonable care, will last a lifetime. The parts are turned out in quantities by automatic machinery, and thus the cost of a first-class article is reduced to a minimum. They are made with cut steel polished pinions, hardened and polished pivots, compensation balances, seven jeweled escapements, and Breguet hair springs. These clocks, when used in dynamo rooms and on switchboards, if so ordered, are fitted with special non-magnetic parts which protect them from magnetism.

ACCURATE TIMEPIECE FOR SHIPBOARD USE.

The clocks run eight days on one winding and are made in several standard sizes, among which are the marine (time only) clocks in sizes 4 1-2 to 12 inch, and also ship's bell clock, in 4 1-2 and 6-inch sizes, and mounted in screw-bezel cases which are especially suitable for yachts and steamships. These sizes of ship's bell clocks, and also larger sizes, when fitted with special bases and with hinged-bezel cases, are adapted for desk or mantel use. The annexed illustration shows a ship's bell clock on a special base, but the round clock may be bought without the base.

Many yachtsmen find that a ship's bell clock is very good for a sleeping room, as the correct time can be told every half-hour, which is not the case with an ordinary striking clock.

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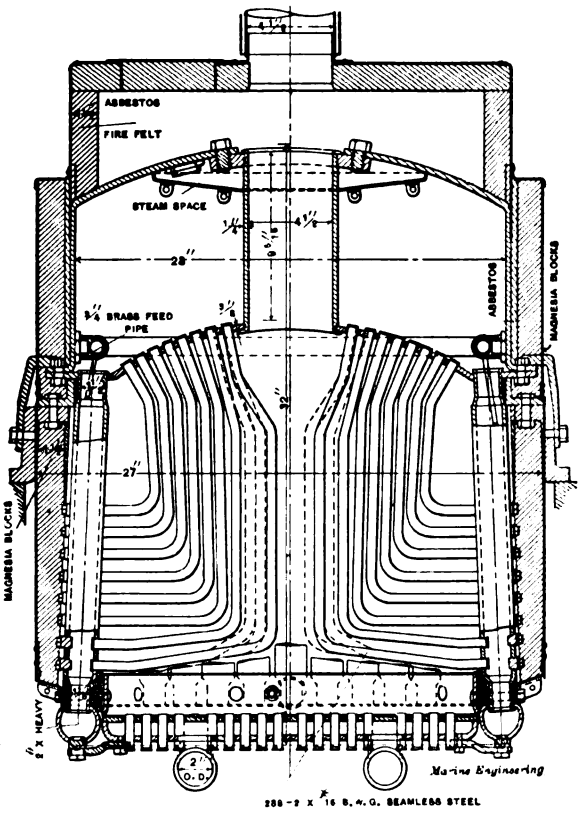
New Boiler for Steam Yachts.

In designing the *Neptune* boiler, fitted with a kerosene-oil burner, the aim has been to supply to the owners and builders of small yachts a safe, efficient, and economical steam boiler of light weight, occupying little space, a quick and rapid steamer, and accessible for cleaning and repairs.

This boiler has many novel features, both in design and construction. It consists of a series of manifold tubes arranged in a circle and placed close together to form the furnace and combustion chamber. The upper ends of the manifolds are expanded into the crown sheet, the lower ends into a mud ring. Within the



NEPTUNE WATER-TUBE BOILER.

furnace are placed the generating tubes, which are bent at right angles, with lower ends expanded into the manifolds and upper ends expanded into the crown sheet. The horizontal parts of the tubes are staggered, so as to close the spaces which otherwise would be made if the tubes were arranged in vertical rows. Covering the crown sheet and bolted thereto is the steam and water drum, a seamless drawn steel shell with dished head. A fire flue is placed in the center, connecting the dished head to the crown sheet, and through this the gases pass to the stack. Within the drum is the internal feed-water ring, placed above the manifold tubes. Openings drilled on the under side of this ring and directly over the manifold tubes, direct the feed water into the descending currents of circulation. At the highest point within the drum, and enclosing the fire tube to which it is fastened, is a baffle, or mechanical separator, from which steam is taken for the engine.

This arrangement of circulation or manifold tubes, and steaming or generating tubes, secures the rapid absorption of the heat by the water, and the continuous supply of water at a high temperature to the steaming or generating tubes.

In a well-designed boiler the best results are obtained by positive and continuous circulation of the water at all temperatures and under natural or forced draft. In this boiler the circulation of the water is positive because proper and definite passages are provided for the ascending and descending currents; those for the ascending currents being directly exposed to the highest temperature of the fire, while the passages for the descending currents are removed from the action of the highest temperature. The circulation is continuous, cannot be impeded or stopped, because the water in the descending passages can never acquire the same temperature as the water in the ascending passages.

Regarding the claim of safety, there are no screwed joints; all the tubes are seamless, their ends expanded and flared or beaded over; there are no welded or riveted seams; the effect of heat on any part of the heating surface cannot produce irregular strains, as all the parts are so constructed as to permit uniform contraction and expansion. The large water and steam drum provides for a considerable variation in the water level and a reservoir for steam, which is of the driest quality due to the fire tube passing through it.

The boiler is very light and occupies little space—one which will evaporate 450 pounds water per hour, from 60 degrees to 100 pounds steam, weighs but 560 pounds, including equipment, and is 27 inches diameter by 40 inches over all in height. The removal of the steam and water drum makes it easy for cleaning or repairs.

In connection with the boiler the designers have perfected a system of gasifying kerosene oil for fuel. This vapor or gas is formed by a special generator placed within the furnace, which, when once in operation, is continuous in action and delivers the gas to the burner, giving a perfect blue Bunsen flame of great heat. As there is complete combustion, there is neither smoke nor odor; and as the use of kerosene is perfectly safe, the equipment of a launch and small yacht with a Neptune boiler fitted with an oil burner makes an ideal steam plant.

The boiler was designed and patented by Messrs. C. F. Davenport and Harry Marks, and is for sale by Worth, Baily and Company, Witherspoon Building, Philadelphia, Pa.

An Improved Boiler Cleaner.

The importance of preventing or removing all scale formations from boilers, for reasons of both economy and safety, is so well established, and the difficulty of accomplishing it so well known, that every advance in this department of engineering is of pecuniary as well as humane interest to both the man who pays the coal bills and the engineer in charge of the power plant.

Innumerable devices and means have been invented to prevent the formation of scale in the boiler, and on the whole the conditions have been slowly improved. Notwithstanding scale still will form, and the means of re-

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moving it are either by entering the boiler and chipping it off by hand or using some mechanical contrivance for doing the same work.

To any one familiar with the construction of boilers, especially of the fire-tube type, where the scale forms on the outside of the tubes, the impossibility of thoroughly cleaning the tubes of this scale by hand is apparent, and is the chief reason for the great favor into which mechanical cleaners have sprung with the trade. All these mechanical cleaners have taken the form of some device or machine which has entered the tube, and has a knocker or rapper that may be operated by hand or power, so as to rap or hammer on the inside of the tube sufficiently hard to jar the scale from the outside.

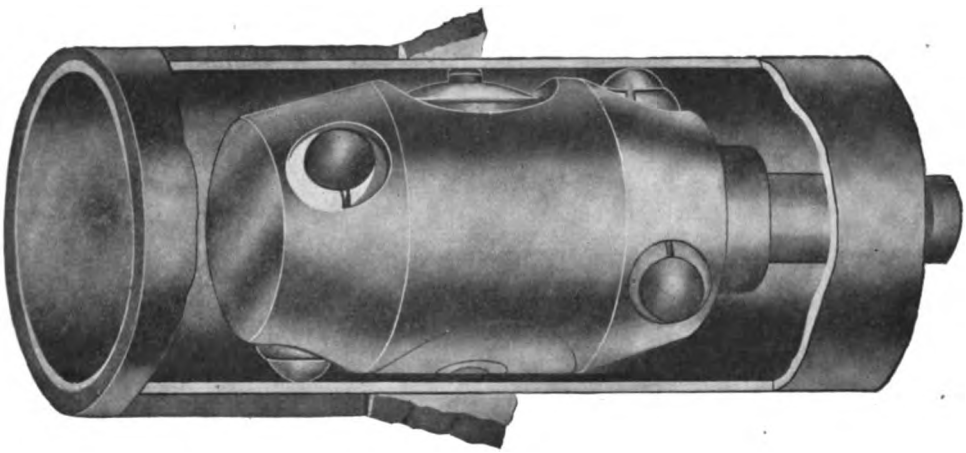
Up to the present time these machines, though simple to handle and effective in operation, have been designed with but one object in view, namely, to strike a sufficiently hard blow to do effective work. The result is that there is danger of injuring the tube, even puncturing it. The most effective and least dangerous method of rapping the tube is evidently in striking the highest possible number of light blows. The effect will be to set up a more or less local but very rapid vibration in the walls of the tube, which, by reason of the more brittle and non-elastic character of the scale formation, breaks up, loosens, and shakes off the latter without subjecting the tube to any undue strain.

The General Specialty Company has devised a steam tube cleaner of high piston speed. A double-acting knocker rod is firmly secured to the piston, and its travel is so limited that, though it is capable of exerting a sufficiently hard enough blow on the tube, it could not puncture it or injure it, because, even though the tube were not present to stop the motion of the rod, it would not travel beyond the point where the walls of the tube would be. This construction makes it possible to safely operate the machine at boiler pressure, thus obviating the necessity of using a separate steam gauge or reducing valve to lower the pressure. Two sets of centering lugs, one ahead and one back of the piston, which are forced out against the inner surface of the tube by steam pressure, accurately maintain the machine in the axis of the tube. Undue heating of the tube from the exhaust steam of the cleaner, with consequent possible loosening of the tube in the heads, is further avoided by expanding the steam before exhausting into the tube, so that its pressure is only a very little above the atmosphere.

An actual test of this machine showed a speed of three thousand strokes and upward per minute, according to the pressure used; nor was the temperature of the tube at the end of thirty minutes raised so much but what it could be easily handled without gloves.

The cut appearing herewith illustrates the cleaner in operation. Further information can be procured from the manufacturers, The General Specialty Company, 74 Carroll street, Buffalo, N. Y.

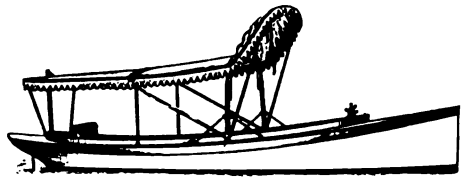
Paper Changes Hands.—The Engineer Publishing Company, Cleveland, Ohio, announces the purchase of *Steam Engineering* and its consolidation with the *Engineer* beginning with the issue of September 1, 1903, from which time subscribers to *Steam Engineering* will receive the *Engineer* twice a month.



BOILER-TUBE CLEANER.

SELECTED MARINE PATENTS.

734,516. LAUNCH COVER. JAMES C. COLLAMORE AND GRANT W. KERST, BROOKLYN, N. Y.



Claim.—1. A launch cover including deck plates, inverted U-shaped fore and aft frames pivotally mounted thereon, a shorter extensible center frame pivoted to said plates, and means for staying said frames. Fourteen claims.

734,519. SLEEPING BERTH. ELIJAH DAWE, COLLINGWOOD, CANADA.

Claim.—1. In sleeping berths, the combination with the side of the upper berth, of a bar pivoted at one end of the same and located to the inside of the berth, a stirrup pivotally connected to the opposite end of the bar and designed with the bar to hang downwardly from the side of the berth when in use. Seven claims.

735,595. DEVICE FOR LOCATING SHIPWRECKS. KUJI SATO, SAN FRANCISCO, CAL.

Claim.—1. A device of the kind described, comprising a buoy, a line of suitable length carried thereby attachable to an object exposed to be submerged, and a line check carried by the buoy and arranged to be engaged by the line when unwinding.

6. A device of the kind described, comprising a reel with a line of suitable length securable to an object exposed to be submerged, a buoy, a frame for supporting said reel and line from said buoy, and a line check carried by the buoy and arranged to be engaged by the line when unwinding.

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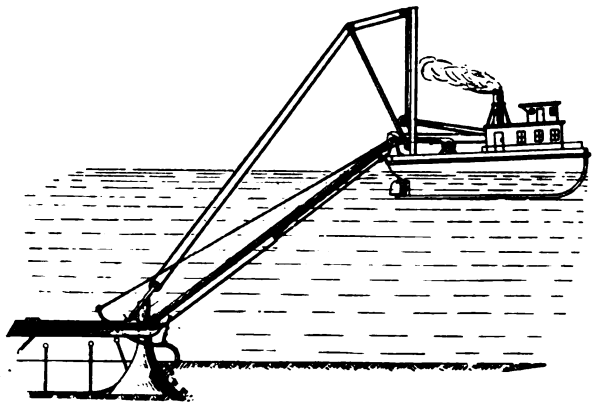
7. A device of the kind described, comprising a buoy, a reel and line of suitable length attachable to an object exposed to be submerged and secured to said buoy, a protective covering for the line on the reel, and a line check carried by the buoy and arranged to be engaged by the line when unwinding.

8. A device of the kind described, comprising a buoy, a line of suitable length carried thereby attachable to an object exposed to be submerged, and a line check carried by the buoy and arranged to be engaged by the line when unwinding, said line check comprising an elongated spring clamp provided with a longitudinal slot the greatest width of which is less than the diameter of the line and through which said line passes and is retarded in its passage.

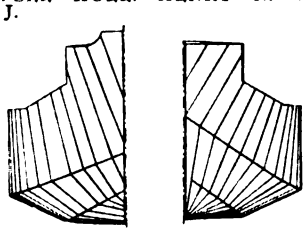
9. A device of the kind described, comprising a buoy, a reel carried thereby, a line wound on said reel attachable to an object exposed to be submerged, and a line check disposed centrally beneath said reel and arranged to be engaged by the line when unwinding. Nine claims.

734,615. SUBMARINE-CABLE-LAYING DEVICE. BEAUREGARD ROBERTS, MOBILE, ALA.



Claim.—1. The combination of a hollow submarine plow, beams adapted to support said plow, an adjustable framework for connecting said beams with a boat, a cable conduit carried by said framework and communicating with a delivery channel in the rear portion of said hollow plow, a fluid-conducting pipe carried by said framework and extending from said boat to a fluid-delivery channel in the forward portion of said plow, and means for raising and lowering said framework and plow. Three claims.

735,637. VESSEL HULL. HENRY N. WHITTELSEY, CAMDEN, N. J.



Claim.—1. An iron or steel vessel hull, embodying a series of transversely extending bottom-frame bars, a series of side-frame bars, the lower ends of which latter exist a considerable distance above the bottom-frame bars, a series of bilge-frame bars formed separately from and extending from the bottom-frame bars to the side-frame bars, the bottom-frame bars at the midship region of the vessel being approximately horizontal, the side-frame bars at such region being approximately vertical, and the bilge-frame bars being at such region at a suitable angle to extend from the bottom-frame bars to the side-frame bars, knuckles being formed at the junctions of the bilge-frame bars with the bottom-frame bars and side-frame bars, said frame bars having shell plate applied thereto.

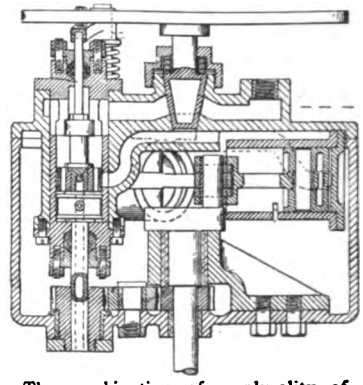
2. A steel or iron vessel hull embodying, in its construction, a series of straight or approximately straight, approximately vertical side-frame bars, a series of transversely-extending bottom-frame bars and a series of straight or approximately straight bilge bars formed separately from and arranged between said side-frame bars and said bottom-frame bars, and arranged at an angle to both, and shell plate applied to the exteriors of said bars. Eight claims.

735,985. ANCHOR-STOWING MECHANISM FOR SHIPS. JOSEPH KIDD, DULUTH, MINN.

Claim.—1. The combination with a hawse pipe constructed at its upper end to be secured to the deck of a ship, of an anchor pocket having a horizontally-disposed compartment for the reception of the flukes of an anchor and an inclined hollow extension secured to and communicating with the lower end of said hawse pipe, said pocket having an opening in its front for the passage of the flukes of an anchor into said horizontal compartment.

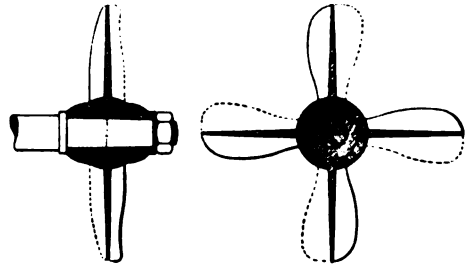
2. The combination with the deck and hull of a ship, each having an opening therein, of a hawse pipe secured to the deck under the hole therein, a pocket secured to the hull of the ship in line with the opening therein, and a hollow inclined extension on said pocket secured to and communicating with the lower end of said hawse pipe. Four claims.

735,675. MOTOR. JAMES L. PILLING AND ROBERT J. KRUSE, PORT HURON, MICH.



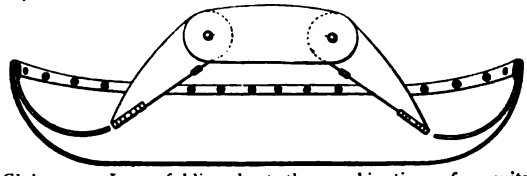
Claim.—1. The combination of a plurality of cylinders, a plurality of pistons and piston rods therefor pivoted to a single crank, a valve casing, a rotary valve provided with a hollow stem therein, means for actuating the valve from the main shaft, passages leading from the valve casing to the cylinders, a main exhaust from the cylinders, and a residual exhaust leading through the valve and through the hollow stem of the valve. Nine claims.

735,905. SCREW PROPELLER. GEORG PINKERT, HAMBURG, GERMANY.



Claim.—1. In screw propellers the combination of the conical shaft, screw blades, fixing flanges on said blades, a spherical boss secured on said shaft, a plurality of spherical segments with recesses adapted to receive the said blade flanges, clamping devices partly overlapping the said segments, and means for holding the various parts together. Six claims.

736,623. FOLDING BOAT. IRA O. PERRING, KALAMAZOO, MICH.



Claim.—1. In a folding boat the combination of a suitable flexible skin; a bottom consisting of central portions having extensions secured thereto by vertical pivots, the whole having cross grooves; hinges arranged toward the inner end of said extensions; hinges having tubular pivots arranged toward the outer end of said extensions; stem and stern ribs adapted to be inserted in said tubular hinge pivots; ribs of suitable spring material adapted to be engaged and retained by said grooves when forced into position, whereby said skin is stretched and collapsing of the boat prevented. Five claims.

736,692. BODY-INDICATING BUOY. HUGH CONDREN, VANCOUVER, CANADA.

Claim.—1. In a body-indicating device, the combination with a cap of an inflated buoyant chamber in the same, a body belt, and a light, strong line connecting them. Three claims.

736,363. MARINE-ENGINE GOVERNOR. IVAR CORNELIUSSEN, GALVESTON, TEX. Five claims.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports that 105 vessels of 25,984 gross tons were built in the United States and officially numbered during the month of August, 1903. One-fifth of this tonnage was of wood sailing vessels, mostly built on the Atlantic and Gulf; another one-fifth of wood vessels propelled by steam; one-half of steel steam vessels, 9 in number; and the remainder embraces one large steel sailing vessel built on the Atlantic.

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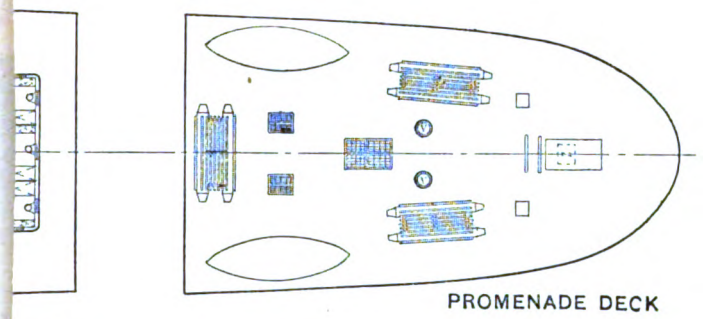

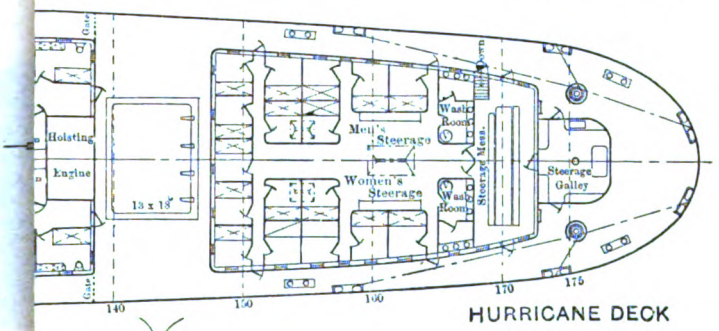

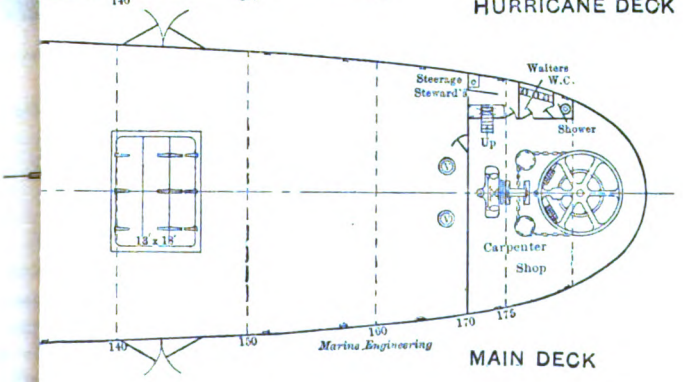

ACH'S SHIPYARD FOR THE MALLORY LINE.

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Marine Engineering

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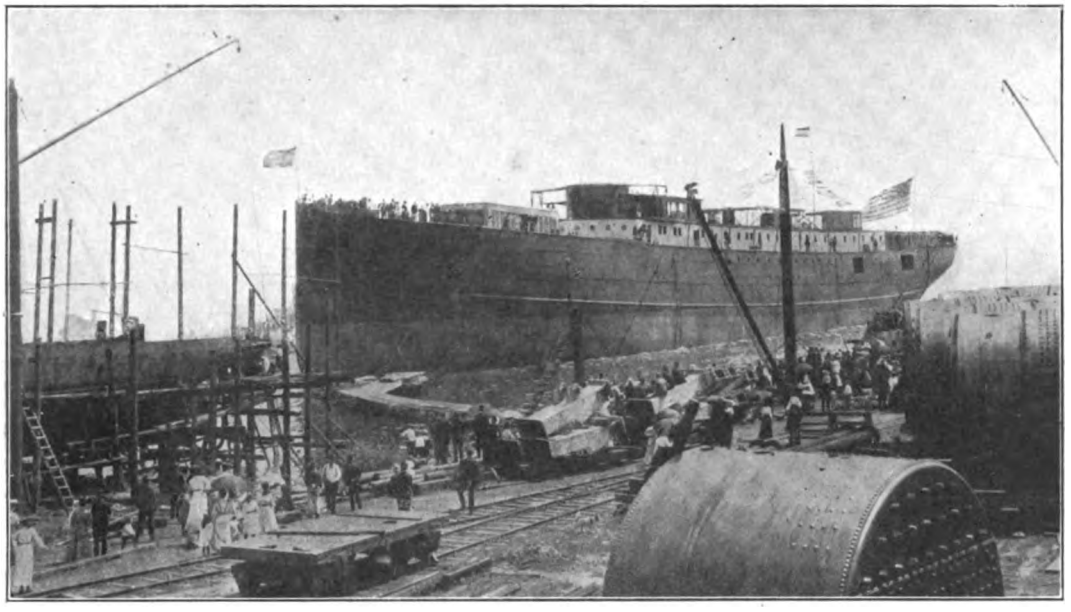
MALLORY LINE TWIN-SCREW PASSENGER AND FREIGHT STEAMSHIP SAN JACINTO.

Among the finest, and equalling if not surpassing the best steamships frequenting our Atlantic coast, will be found before the ushering in of the year 1904 the New York and Texas Steamship Company's steamship *San Jacinto,* designed, built, and equipped by the Delaware River Iron Shipbuilding and Engine Works, more familiarly known as Roach's Shipyard, at Chester, Pa. As is well known, this steamship company, C. H. Mallory and Company, agents, operates a line of steamers between New York and Galveston, Tex., touching at several intermediate points en route.

GENERAL FEATURES.

The *San Jacinto* is built to the rules and under survey of the U. S. Standard Steamship Owners', Builders', and Underwriters' Association, Ltd., with tested material, of the hurricane-deck class for coastwise service, A1 for twenty years, having single bottom, six water-tight and three non-water-tight bulkheads, with orlop deck forward to No. 2 bulkhead, which divides the fore hold, and having in common with the lower, main, and forecastle decks channel-section beams 10 by 3 1-2 by 3 1-2 inches, secured to alternate frames by gusset plates.



LAUNCHING THE TWIN-SCREW STEAMSHIP SAN JACINTO FROM ROACH'S SHIPYARD.

In the latest intended addition to this familiar line the public will appreciate a type of vessel very different from those now engaged in this trade. The *San Jacinto* is a twin-screw ship, and in this respect the pioneer of the Mallory Line; this feature they were loath to adopt when the builders first presented it for their consideration. Realizing, however, the difficulty of embodying large carrying capacity with high speed on limited draft of water, they were finally convinced of the necessity for accepting it.

On the contract draft this ship's coefficient is just under 70 per cent., which is readily appreciated as a trying proposition for high speed. On this draft the cargo-carrying capacity will be 2,500 tons and the coal capacity 1,250 tons in addition, or a dead weight of 3,750 tons.

The forward orlop deck is wood covered by spruce, 4 inches thick. The lower and main decks, extending all fore and aft, are completely steel covered and water-tight and without wood. The forecastle deck has 10-pound steel plates upon beams and covered with a 3 1-2-inch cypress deck plank. No. 2 hold is in the deep hold extending from ship's floors to lower deck. At the orlop-deck height the side stringer extends aft to after collision bulkhead. At this height, abaft the engine room, are cargo platforms covering tops of shaft tunnels and water tanks. Outside of tunnels at forward ends of same are cargo holds extending from the ship's floors to the lower deck, and near the after end of tunnels this cargo hold is between the two tunnels, while at the extreme after end is the large fresh-water tank of 100 tons capacity for make-up water for main-

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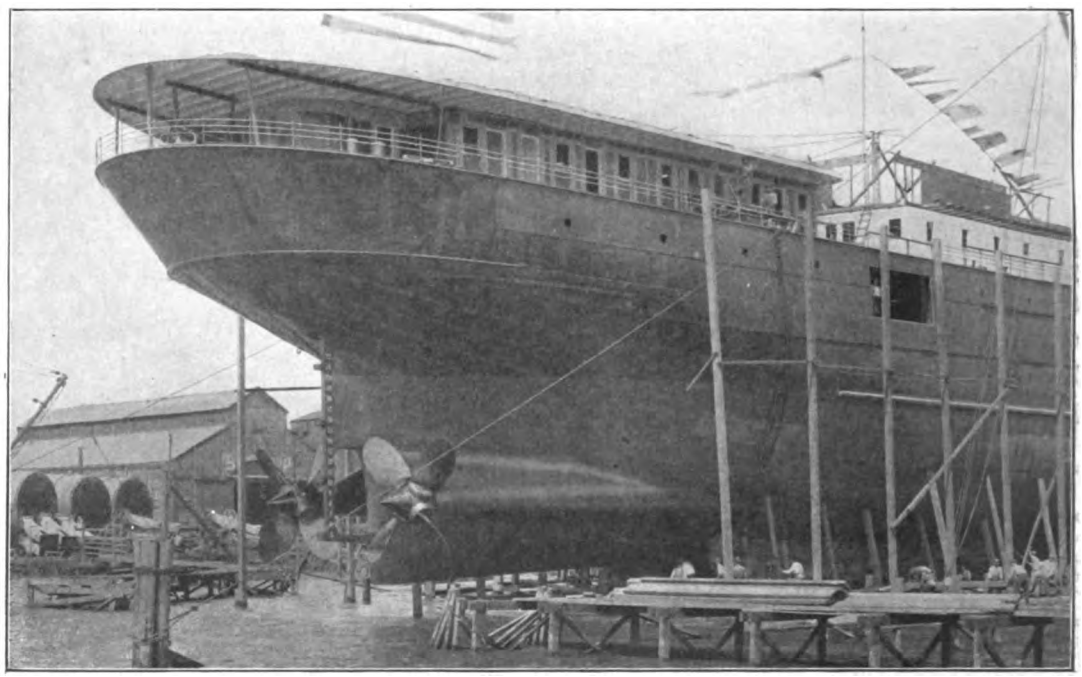
boiler use. This tank is so located that it utilizes a space that would otherwise be wasted or rendered expensive for cargo handling owing to the sharpness of the vessel at this point.

There are six over-all and three blind hatches. The cargo is handled through these blind hatches by means of cranes and Lidgerwood hoisting engines, 5 by 8-inch cylinders, the hatches of lower deck having wooden covers. Half-round iron is riveted to the under flanges of beams and carlins to prevent chafing of whips when handling the cargo. The main-deck hatches have high coverings and water-tight hinged steel covers, as have also the hurricane and forecastle decks; the coverings of main deck being flanged under beams and carlins to prevent chafing, etc.

GENERAL ARRANGEMENT, HURRICANE DECK.

The plan of the hurricane deck from stem to stern is as follows: First, a steel companionway, leading to crew's quarters and windlass engine in forecastle; next aft is No. 1 over-all hatch, 10 by 10 feet; continuing aft is the forward steel house, enclosing two Lidgerwood hoisting engines, one at each end; and in the center of the house is the baggage room, the foremast extending down through the same. On each side of this forward house are cargo posts, two being abreast of the forward end and two abreast of the after end, used for derricks to handle the cargo through Nos. 1 and 2 hatches. The forward derricks have a capacity of 8 tons and the after pair a capacity of 12 tons each, handled by the two hoisting engines in forward house



VIEW OF THE STERN OF THE SAN JACINTO JUST BEFORE LAUNCHING.

From No. 2 hatch the beams of hurricane deck are 6 by 3 by 3 inches, gusseted to alternate frames and clipped to hurricane deck, sheer strake between them, the alternate frames only extending to hurricane deck, the intermediate ones stopping at main-deck height from No. 2 hatch to within 30 feet of the stern; from this point around the stern and from stern to No. 2 hatch all frames extend to the hurricane deck. From No. 2 hatch aft, the hurricane deck is covered with 5-pound steel plates as a preventive against fire reaching the cabins, should such occur in upper cargo between decks, and on top of this is laid a cypress deck. The ship is rigged as a two-masted schooner, with steel masts, having four sails, awnings, weather cloths, etc., complete. On the after side of foremast a 30-ton derrick will be provided for handling heavy cargo through No. 2 over-all hatch. On the after side of mainmast two 12-ton derricks will be installed to handle cargo through No. 3 over-all hatch.

mentioned above; these engines are double drum, double cylinders, 8 by 8 inches, with winch heads on each end of drum shafts for extra hoisting, etc. No. 2 is what is termed a cut-down hatch, having hinged water-tight covers or shutters, which raise up aft and rest against the fore end of promenade deck. Abreast this hatch, side or gangway ports swing open fore and aft, permitting cargo handling over the main deck sheer strake, avoiding thereby the necessity of hoisting it to the height of the hurricane deck, which otherwise would be the case.

Next aft is the central steel house enclosing the first-class passenger accommodations and 225 feet in length. In the forward end of this house is the dining saloon, with round lights in front and drop-sash windows and blinds on the sides. Sliding doors on each side open into lobbies, from which the dining room is entered, and passageways and state rooms extend aft to a large and attractive cabin. All the inside facework, includ-

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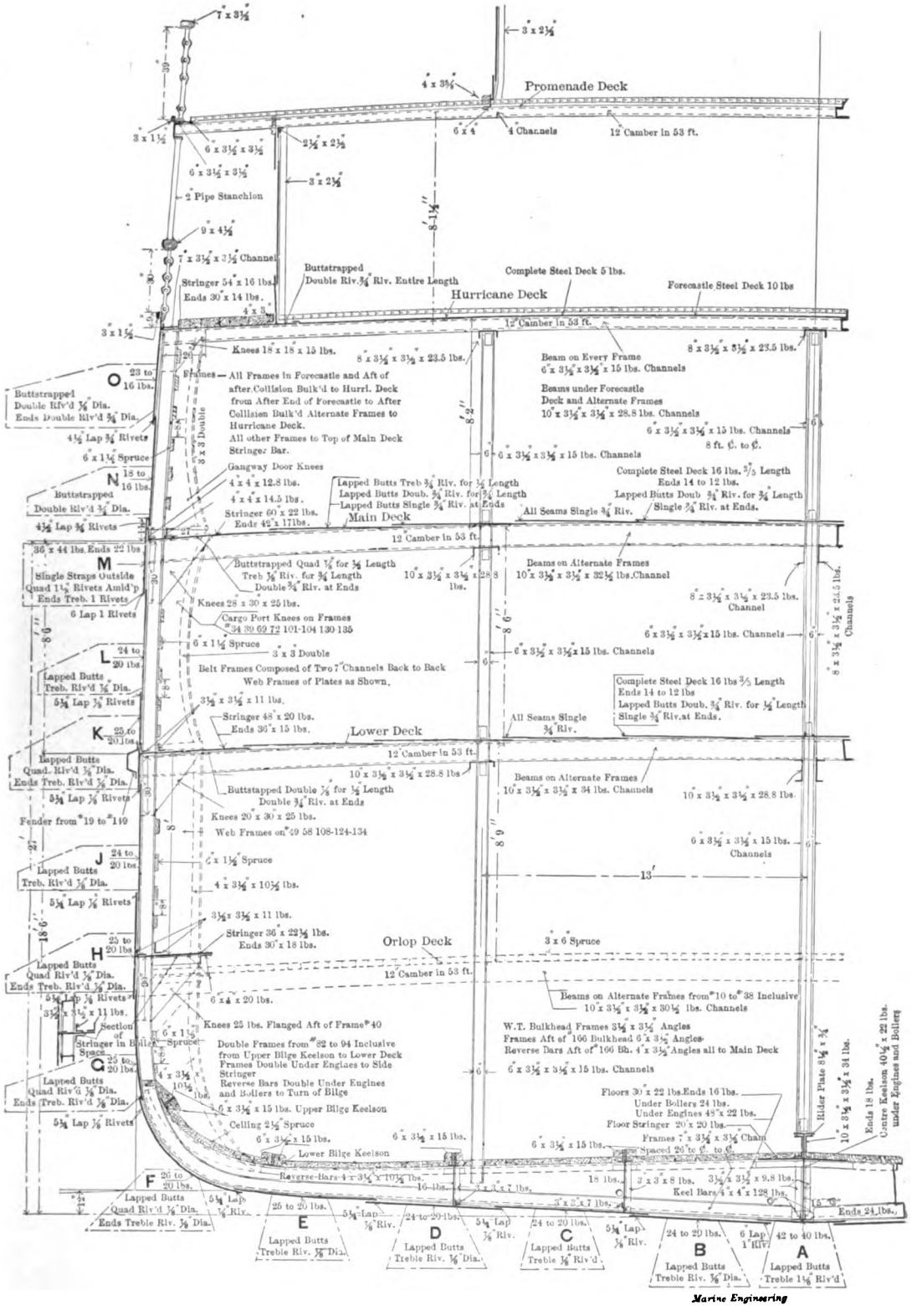

MIDSHIP SECTION OF THE SAN JACINTO, BUILT FOR THE NEW YORK AND TEXAS STEAMSHIP COMPANY (MALLORY LINE) AT ROACH'S SHIPYARD.

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ing the dining saloon, is finished in highly-polished, handsomely-grained quartered oak attractively paneled. In the center of the ship, and immediately connecting with the dining saloon at after end, is the pantry, equipped with all the necessary equipment looking to the perfect service of a first-class passenger ship, being fitted with dressers, plate racks, sinks, pumps, ice boxes, refrigerators, steam tables, plate warmers, etc., complete in every particular. The pantry is situated directly over the kitchen, having access thereto by means of stairs and dumbwaiter, is well lighted and ventilated by skylights and air shafts, as is also the kitchen below, and the service from kitchen to pantry and to dining saloon is very direct and convenient. As stated before, passengers leaving the dining saloon pass into the lobbies on either side and down the inside passageway to ladies' cabin or to their state rooms. From the starboard passageway access is had to the smoking room above by a stairway recessed into the pantry. All the first-class passenger state rooms on this deck are entered from the inside passageway or ladies' cabin. The rooms are large, light, and airy, and each is fitted with drop-sash window and blinds, with white-enamel folding berths, porcelain wash basin and cast-iron receiver, tumbler and towel rack, mirror, etc., electric light, steam heat, call bell, and all modern conveniences, inviting the traveler to rest and comfort in either winter or summer.

The ladies' cabin is well lighted and ventilated; large prismatic glass lenses set in the deck above light up the passageways by day, while beautifully-arranged electric lights brighten them and the saloons by night. The mainmast extends down through the center of the ladies' cabin and is cased with polished quartered oak. A large well hole encircling the grand stairway at forward end of cabin, also of quartered oak, leads to the social hall above; while a large and handsome mirror at second landing gives a fine effect to the whole apartments, which are handsomely furnished with fixed couches and chairs.

Midway of the first cabin, with cross passage connecting the side passageways, and between the boiler and engine enclosures, are the first-class toilet rooms. The women's, on the port side, has handsomely tiled floors and tiled wainscoting, flushing closets, marble wash stand, and a bath room with porcelain tub and shower baths. All the quarters are well lighted and aired by an air shaft leading up through the houses above to a skylight. On the starboard side are the men's toilets, similarly arranged in regard to baths, wash basins, light, air, etc. Connected with both closets also are air ducts leading into the outer casing of main smokestack, which will supply an induced exhaust draft that will insure pure air for these quarters. The plumbing here, as well as elsewhere throughout the ship, is of the best, and is supplied and installed by Mr. H. C. Calkin, Jr., New York, N. Y.

PROMENADE DECK.

The social hall, on the promenade deck, is finished in white maple beautifully paneled and polished, the grain producing a fine effect. The few passenger rooms within this hall are provided with all the comforts of those below, being equally pleasing and inviting. Over the grand stairway a handsome dome supplies light for the cabin; and aft of the mainmast, which passes down through the center of these quarters, is a skylight, with a well-hole through social-hall deck to give light to the after end of the ladies' cabin. From the social hall large sliding doors permit the passenger to reach the promenade deck and fresh air.

From the forward end of dining saloon to the after end of ladies' cabin the outside deck space makes a fine promenade, 225 feet in length, for the use of first-class cabin passengers in fair-weather days. Aft of the first cabin is No. 3 over-all hatch, 13 by 18 feet, the cargo from which is worked, as before mentioned, by two cargo derricks, with engines enclosed in the after end of first-cabin steel house. Aft this No. 3 hatch is a steel house, the deck of which extends over to the side of the ship for shelter; here are the second cabin or steerage passengers' quarters, finished in pine neatly paneled. This house is divided centrally fore and aft for the men and women; the state rooms are fitted with three high iron-pipe berths, making a total capacity of fifty-one; separate wash rooms and water closets are provided. A common mess room, with steam kitchen attached, directly aft, provides for the necessities of life during the voyage. These quarters are exceptionally well lighted, aired, and equipped with respect to comfort and conveniences.

On the forward end of promenade deck and over the dining saloon is the steel pilot house, finished inside with sycamore and equipped with all instruments necessary for the proper navigation of the ship. Above the pilot house is the bridge, upon which is located a steering wheel and a 1,000-candle-power searchlight, operated from within the pilot house as well as on the bridge. Abaft the pilot house is the captain's room, finished in polished sycamore, and well furnished with the conveniences of bath, wash room, and water closet. Aft of the captain's room the steel house widens to accommodate the first officer on one side, and the second and third officers' quarters on the other. These rooms are finished in quartered oak and made as comfortable and homelike as possible.

Aft of the officers' quarters is the smoking room, with stairway, as before mentioned, leading below. It is handsomely finished in paneled hazel richly polished, and is every way attractive and convenient, supplied with seats and chairs tastefully upholstered, card tables, etc. A toilet room is placed at forward end, abreast of the captain's bath room. All these rooms are well lighted and ventilated with domes, windows, and skylights; a skylight passing down through a trunk in forward end of smoking room permits light and air reaching the pantry and kitchen below.

Aft of the smoking room is the fidley or smokestack enclosure; aft of this is the social-hall steel house before mentioned, in the end of which is the chief engineer's room, with inside door leading direct to the engines. The chief engineer lacks nothing for convenience and comfort, and is taken care of in a manner at once appreciated. There are three outside passenger rooms in the fore end of this social hall, in the center of which, at the forward end, are stairs leading to the boats placed on the deck above, which extends over to the side of the ship, making a permanent shade deck. There are four large boats, 23 feet 3 inches long, on

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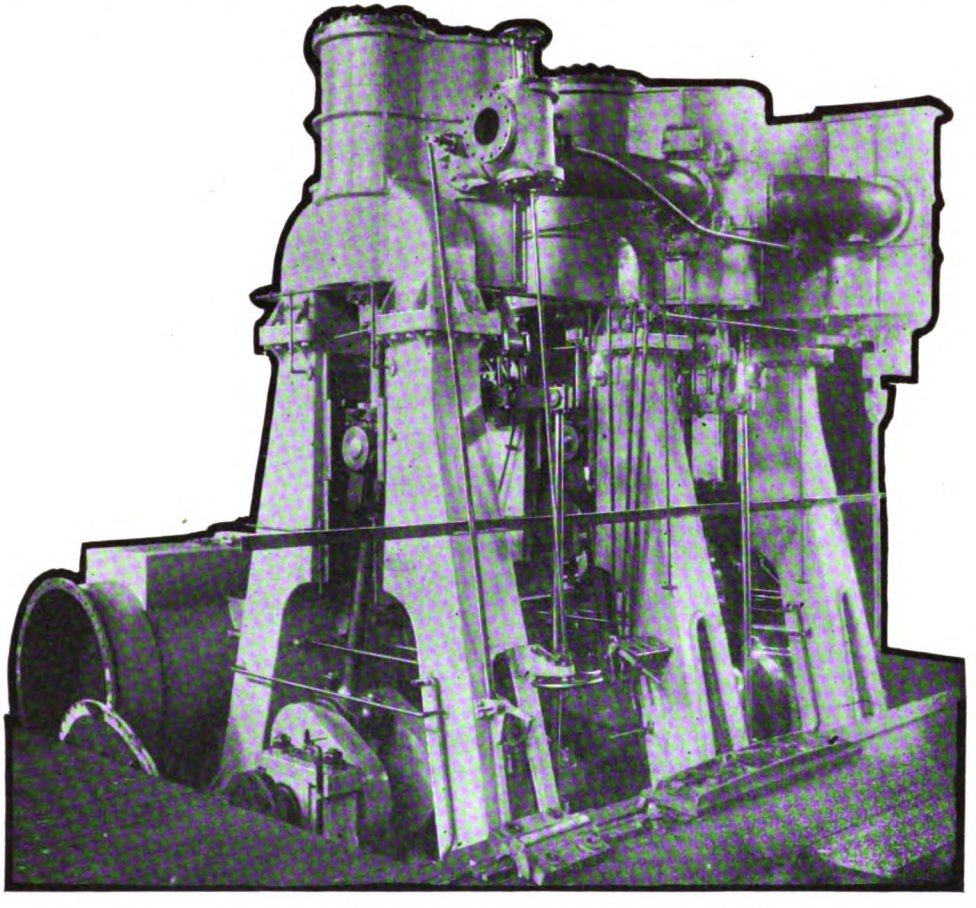
this shade deck, operated with the Mallory boat davit gear. On the after or steerage house are two more boats of this size and three liferafts. This ship is amply equipped with safety devices and passenger security against possible accident, in excess of all government rules and regulations.

In outside appearance the *San Jacinto* will resemble somewhat the *Denver,* of the same line, but is much larger and more powerful. Rigged, as before mentioned, as a two-masted schooner, with proportionally distributed deck houses, etc., she will make a striking picture as she sails on her maiden trip from New York about December 15 next. Her principal dimensions are: length over all, 404 feet; length on the water line, 382 feet; beam, molded, 53 feet; and depth, molded at half length of hurricane deck, 35 feet.



ONE OF THE TWO 3-CYLINDER, TRIPLE-EXPANSION ENGINES FOR THE SAN JACINTO.

HULL CONSTRUCTION.

In hull construction the most striking feature, perhaps, from an owner's point of view, is the scarcity of stanchions; stiffness and strength being secured by the suspension-girder system or ridge-bar connection under beams, which consists of channel-section material. The center girder is double, with webs vertical and upper flanges securely riveted to the under side of the channel beams of the several decks. These channel girders are back to back, but far enough apart to permit a row of double channel-section stanchions being riveted between them, the stanchions also being riveted to the beams; these center stanchions are spread 8 feet apart. At quarter breadth are fore-and-aft girders, with webs riveted to the under side of deck beams, and with double channel-section stanchions securely riveted to their under side, spaced 16 feet centers, or double the distance of the center ones. This construction is adopted throughout the ship; in the holds as well as in the between-decks wood is filled in between the flanges of all stanchions, to prevent chafing of freight, etc. This ship is built on the channel system, channels being used wherever possible and desirable. The frames are 7 by 3 1-2 by 3 1-2-inch channels, in one piece from keel to hurricane deck at ends and to main deck and hurricane amidships alternately, being spread 26 inches apart. Beams of channel section are elsewhere described. In other respects the construction is similar to all the coastwise steamers.

MAIN DECK.

On the main deck, beginning forward on the starboard side, is the crew's wash room and water closet; the crew's quarters, or forecastle, being fitted with iron-pipe berths.

The windlass engine, having double cylinders 12 inches in diameter by 12 inches stroke, is located on the main deck; while the windlass is on the hurricane deck, and directly aft on the hurricane deck is the forward

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capstan, geared from the windlass engine. There are two bower anchors (the Baldt stockless type) and 270 fathoms of 2 1-4-inch chain cable handled with this windlass and gear, which is of the Hyde Windlass Company manufacture. On the port side, main deck, are the store rooms, boatswain's, carpenter's and watchman's, also quartermaster's rooms.

The forecastle is separated from the upper between-deck freight space directly aft by a steel bulkhead. Aft this freight space and forward of boiler enclosure on main deck is the kitchen; central of the ship, and on each side of the kitchen, with passageway between, are two ice houses having a capacity of 20 tons each; aft the ice houses are the firemen's quarters, porter shop, water tenders', oilers', and first, second, and third engineers' rooms, on the port side; while on the starboard side are the mess room for officers, store rooms, waiters' quarters, and cooks' rooms, all comfortably located, equipped, and lighted. Toilet rooms for the crew and petty officers are amidships, between the boiler and engine enclosures, and consist of wash rooms, bath tubs, and shower baths complete, all well lighted and ventilated through an air shaft leading to top of houses. The steel deck throughout the midship quarters will be covered with plastic cement.

Abaft the engine room and midship quarters is the after upper between-deck freight space; at the after end of which, enclosed by a steel bulkhead, is a powerful steering gear governed and controlled by a massive Sickles steering engine, the same pattern as has been built for years at the Roach works. The engine is located just forward of the immense steering wheel on rudder stock, and is connected direct therewith by heavy tiller chains which hug the steering wheel in separate grooves. The rigidity of the connection with the rudder is relieved by means of strong springs attached to the tiller, which is keyed to the rudder stock. These springs take care of any jar that would otherwise be thrown directly upon the engine and its connecting gear whenever the rudder is buffeted by an angry sea. The tiller chains go directly to the drum of the steering engine through large quarter sheaves strongly secured to the main deck. The operating of the steering engine valve is had through a line of flexible shafting leading forward through freight space and up to the pilot house and bridge deck, and is in perfect control at all times. The rudder stock is extended up through the hurricane deck, through the steam kitchen for steerage passengers, to the deck above, where is located a large right- and left-hand screw gear controlled by three large hand-steering wheels, which constitute the inner quarry steering gear. There is also in addition a spare tiller below, with relieving tackle, to be used in case of accident to the main gear. There are also rudder pendants provided on the outside of the ship for immediate use, should it be necessary. The tiller, which is keyed to the rudder stock, has a large friction gear attached, by which it is possible to catch and secure the rudder in any position, should anything happen to the tiller chains. This whole steering arrangement is strong and substantially equipped, and, while ponderous in weight and strength, can be easily controlled.

ENGINES.

The propelling machinery consists of two sets of triple-expansion engines having cylinders 27 1-2, 44 1-2, and 70 inches in diameter by 42 inches stroke, turning twin propellers with right- and left-hand pitches, the tops of which turn outboard. The cranks are placed at equal angles. All the valves are of the piston variety and actuated by Marshall valve motion. Liners are fitted in the high and intermediate cylinders. The bed plates are of strong box form, the cylinder of each engine being supported upon two wide-spreading cast-iron columns resting upon two large flanged brackets of the bed plates; thus there are six columns to each engine. The cylinders are not tied together, having copper receiver pipes connecting the steam passages, but at the back and close up to the top flanges of the columns cast-iron bridges or ties are fitted as the means of securing the cylinders.

The cast-iron plate condensers are separated from the engines, being round in form and secured to large brackets cast on the bed plates. They have 3-4-inch brass tubes packed with screw ferrules, the cooling surface of each condenser being about 5,000 square feet. Pipes for boiling out and pumps for washing these condensers are supplied. The air pumps are driven from the low-pressure crossheads and have two bilge pumps at their sides attached to each. The air pumps are 24 inches in diameter and 18 inches stroke. Each main engine has its own circulating pump, which is centrifugal in its action and connected by means of cross pipes and valves with the condensers, giving each pump separate condensers, or either or both, as the engineer or conditions in the engine room may dictate; the feed pumps, sanitary pumps, bilge pumps, and fire pumps being ample in size and capacity.

The crank shafts are of the built-up type, in three pieces, and interchangeable. Crank pins are 13 1-4 inches in diameter by 14 inches long, the sequence of the cranks being: high-pressure, intermediate-pressure, and low-pressure. The thrust shafts are 13 1-4 inches in diameter, having couplings forged on and ten collars. The collars are 20 inches by 2 inches thick, working in oil bath in the horseshoe thrust, with bearing at each end of thrust-collar rings resting upon plumber blocks at each end of thrust-block casting. The intermediate or line shafting is 12 7-8 inches in diameter, with solid couplings forged on each end; each piece of line shafting being carried on two pillow-block bearings, the diameter of shaft bearing being 13 1-4 inches. The tail or propeller shafts are 13 1-4 inches in diameter, having a solid coupling forged on inner end; while the outer end is covered with a gun-metal sleeve the full length of the bushings or bearings within the stern pipes, said bearings consisting of end-grain lignum vitæ. The after end of the shaft line, including the stern bushings, is enclosed within the hull of the ship upon the patents of Captain Lundborg, for which purpose the builder took out a license.

All the shaft couplings have cross keys and parallel coupling bolts, and turn upon white-metal-lined cast-iron boxes. This metal is used throughout the machinery and gives entire satisfaction. The shafting and all principal forgings were furnished by the Bethlehem

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Steel Company and are of fluid-compressed steel throughout.

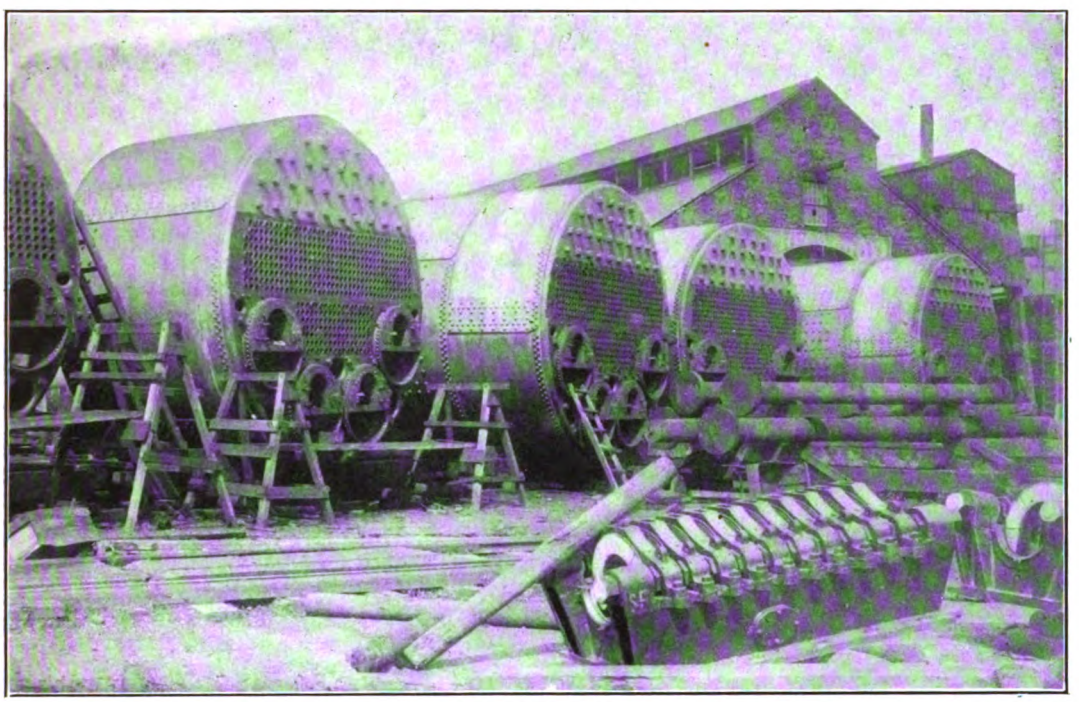
All the working parts of the engines, piston rods, connecting rods, valve stems and rods, etc., are in size and stiffness beyond the figured stresses likely to be put upon them, wearing surfaces being ample in a liberal degree. The piston and valve-stem stuffing boxes are fitted throughout with the latest and most improved United States metallic packings. Reversing engine of the ram floating-lever type, 8 inches diameter with a stroke of 13 1-2 inches, and taking steam from main and auxiliary steam line, gives the engineer perfect control of his engine. The main throttle valve, which is of the double-ported, balanced-valve type, has between it and the high-pressure valve chest a butterfly valve, the handle of which extends down to the starting platform, giving the engineer on watch full control, enabling him to check racing of the propellers when the ship's stern is thrown partially out of the sea by the waves.

A steam turning gear, located centrally in after end of engine room, having link motion, with double cylinders 8 inches diameter by 10 inches stroke, geared to a pinch wheel on the after coupling of each crank shaft, is controlled by means of a hand-gear attachment to turning-engine flywheel.

A complete water service of brass pipe is fitted around the main engines and through the shaft tunnels. Oil lubrication is amply provided for all the principal working parts, siphon and approved sight-feed lubricators being freely used. Oil pumps are installed to collect the waste oil from the various pockets about the machinery and deliver into an oil-pumping tank for economical reasons.

A feed heater of the Wheeler type is fitted in the discharge line to the boiler, the steam not used by heater going to the low-pressure receiver, and so on to the condenser; both main feed pumps pump through this heater as well as to the main boilers direct. An auxiliary condenser and pump, amply large and sufficient in capacity for the purposes intended, are installed. All pumps are of the Blake type, of the following dimensions:

Feed pump, two.....12, 8 1-2 by 12 in. duplex
Fire pump, one.....12, 8 1-2 by 10 in.
Donkey-boiler feed, one.....6, 4 by 6 in.
Salt-water sanitary, one.....6, 5 3-4 by 6 in.
Fore and aft peak tanks, two.....4 1-2, 4 by 4 in.



A GROUP OF BOILERS AT ROACH'S SHIPYARD FOR THE NEW TWIN-SCREW STEAMSHIP SAN JACINTO.

BOILERS.

The boiler power consists of three double- and two single-end Scotch boilers, built for a working pressure of 180 pounds per square inch, all of 16 feet diameter, the double-end boilers being 18 feet 6 inches long and the single-end 10 feet 5 inches. Each single-end boiler has four removable furnaces, supplied by John Brown and Company, of England, 40 inches inside diameter, and having common back connections. The double-end boilers are fitted with eight such furnaces. There are 470 3-inch tubes, the proper number of them being stay tubes. On a 6-foot bar the total grate surface is 640 square feet, the total heating surface being 22,400 square feet. The three double-end boilers are placed abreast of each other, separated from the engine room by a coal bunker. The two single boilers are amidships forward of the double boilers, thus giving two athwartship fire rooms, the after fire room taking care of twelve furnaces and the forward fire room providing for twenty. Coal is conveniently stowed in several lower

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bunkers, and directly above in the lower between-decks, descending without much labor to the fire rooms. The total capacity of the bunkers is 1,250 tons. The between-deck portion is used on the run South, leaving the space available for cargo on the return voyage, the lower bunker coal being ample for the return trip. The main boilers, also the donkey boiler, built by the New York Shipbuilding Company, of Camden, N. J., are exceptionally fine pieces of boiler maker's handiwork. The smoke and heated gases from main and donkey boilers escape through the breeching into the uptake, which delivers them into a huge stack divided into three compartments or flues, the after ends of the double boilers having their gases delivered into a common compartment of the stack, and in the same manner the fore ends of these boilers deliver gases into a common chamber, as do also the two single-end boilers; the donkey boiler has a stack to itself within the main stack. The main stack is double and elliptical in form, 15 feet fore-and-aft diameter by 11 feet athwartships, and with a total height above lower furnaces of 100 feet. The escape pipe mounting to the top of the stack is 14 inches diameter.

All necessary mountings and fittings for the boilers are supplied, including Ashton pop, spring-loaded, easing-gear safety valve, twin connected on the valve chests of the boilers (the double-end boilers having safety valves at each end); injector connections, main stop valves, surface and bottom blow valves, drains, gauges, zinc plates; Korting ejectors arranged for water circulation when getting up steam; water columns and gauge glasses having electric lights fitted behind them to show the water level from all parts of the fire rooms.

Two ash ejectors, one in each fire room, are installed for ready use in discharging ashes; in addition to which are steam hoists delivering ashes to the upper platforms, from which they are dumped overboard. For proper and sufficient supply of fresh air into the fire rooms there are four extremely large ventilators, the hoods of which are under the control of those below, and will either deliver air into the fire rooms or exhaust it. Large ventilators are also supplied for the engine room. An ample supply of tools, fittings, spare parts, etc., for both engine and boilers, will give security to this entire plant.

In the aggregation of so much boiler and engine power within a very limited space accorded to them, the designers have certainly had regard to the owners' most important and desirable acquisition, that of economy of space for their propelling machinery; for, occupying as it does the very heart of the ship, a wasteful expenditure of space here robs the owner of the very thing for which he builds his ship—the storage of large cargoes, whereby he hopes to receive a profitable return for his outlay of money and energy. In the present instance no complaint of this character can be laid at the door of the designers; for while ample space is provided for every necessary thing and all parts of machinery are accessible, yet not a foot of space is wasted, nor is there a corner or pocket where good light and ample fresh air are not to be found.

This ship and her propelling power throughout will be complete and up to date in every particular, and every one having to do with the *San Jacinto*, whether furnishing material or supplying labor, will be proud of the fact that from keel to trunks she equals any coastwise steamer afloat.

Telegraph and call bells, consisting of engine telegraph, double-faced transmitters on each end of bridge, in pilot house, and on each side of ship aft, connected with indicators in engine room, etc., give the captain perfect control of his ship at all times. Docking, steering, and rudder-indicator telegraph and the like add to the security. Speaking tubes to all important points keep the captain and engineer in perfect knowledge of what is transpiring within and without. There are calls to forecastle, crow's nest on foremast, chief engineer's room, engine room, fire rooms, captain's room and pilot house, mess rooms and kitchen, windlass, etc., and electric calls in all state rooms enable the passengers to have their many wants attended to at once. The system throughout was furnished and installed by Messrs. Charles Cory and Son.

The electric-lighting system, which is very complete and most artistically arranged in the cabins, goes a long way in making up an agreeable, comfortable, and pleasing ship in these days. Current is furnished by two 20 Kw. multipolar marine-type generating sets, being in duplicate; that is, all wiring being common to both machines, which are of the General Electric

NAME—San Jacinto. NATIONALITY—American. TYPE—Coaster, passenger, and freight steamer.
LAUNCHED—1902. BUILDER—Roach's Shipyard. OWNER—New York and Texas Steamship Co.

Length over all	404 ft. 0 ins.
" between perps	379 " 2 "
" on water line	382 " 0 "
Beam, molded	53 " 0 "
Depth, " main deck	27 " 0 "
" " hurricane deck	35 " 0 "
Draft, load	19 " 0 "
Displacement, load draft	7,600 tons
Dead-weight carrying capacity	3,750 "
Block coef	.70
Speed, sea	17 knots
Engines: Number	2
I. H. P., designed sea	6,500
R. P. M., " "	110
M. E. P., reduced	36.2 lbs.
Type	3-cylinder, triple
Cylinder diams	27 1-2, 44 1-2, 70 ins.
Stroke	42 "
Valves	piston, all cylinder
" diam	12, 18, 30 ins.
Valve gear	Marshall
Piston rods, diam	6 3-4 ins.
Crank pins, "	13 1-4 "
Shafting, diam. crank	13 1-4 "
" " thrust, 20 ins. and	13 1-4 "
" " line	12 7-8 "
Shafting, diam. propeller	13 1-4 ins.
Condensers	two, cast-iron shells
Cooling surf., each	5,000 sq. ft.
Tubes, brass, diam	3-4 in.
Air pump	direct-connected
Size	24 ins. diam. by 18 ins.
Propellers: Number of blades, each, 4	
manganese bronze blades and cast-steel hubs.	
Diam.	15 ft.
Pitch	20 "
Area, each wheel	76 sq. ft.
Boilers: Number	3 double-end, 2 single-end
Length	18 ft. 6 ins., 10 ft. 5 ins.
Diam.	16 ft.
Pressure	180 lbs.
Furnaces: Number each	8, 4
Diam. inside	40 ins.
Length of grate	6 ft.
G. S. total	640 sq. ft.
Tubes, diam	3 ins.
Length between tube sheets	6 ft. 10 ins.
Number	968, 470
H. S. total	22,400
H. S. + G. S	35.0
I. H. P. (designed) + G. S	10.2
H. S. + I. H. P. (designed)	3.45
Admiralty coef.	291.

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manufacture. The electrical fixtures, the design and handiwork of Jas. Barre and Company, will be the equal of anything in existence to-day. Besides the electric lighting will be provided an auxiliary oil lamp and candle effect. Electric fans will make the dining saloon pleasant and agreeable on sultry days, and other equally pleasing effects will be found throughout the whole of the first-class passenger quarters. Cargo spaces are lighted with electric clusters, etc., and the running or ship's lights are fitted for both electricity and oil. A powerful searchlight, elsewhere mentioned, is located on bridge.

This ship is fitted for 80 first-class passengers and 51 second-class or steerage passengers. She is expected to exceed her contract requirements, as do the Roach-built ships generally.

Measure of Speeds of Ships at Sea.*

NOTE BY E. GUYON.

The problem of the measure of the present high speeds of ships has not yet received satisfactory solution. The use of the ancient type of chip log is no longer practicable for speeds beyond 14 or 15 knots, and the so-called patent logs with propeller, which are towed by the ship, involve several undesirable features, of which one of the most serious is the frequent danger of loss. As to logs based on the principle of Pitot's tube, it has not yet been practicable to devise one which can be considered entirely satisfactory.

On nearly all ships which are propelled by steam alone the speed is commonly estimated from the revolutions of the engine. This method has the disadvantage of supposing known the advance per revolution of the shaft, and this advance varies with various circumstances, regarding which it is not possible to always appreciate in advance, the influence. But this method is so simple and practicable and is so well grounded in practice that it may be fairly considered as the most satisfactory, provided that it could be relieved of the single disadvantage, as mentioned above, by the provision on each ship of an instrument permitting the measurement of the advance per revolution as often as its value might appear uncertain.

This requirement may be fulfilled by an instrument based on the principle of some one of the logs mentioned above, since it would be sufficient for all purposes to measure simultaneously the speed of the ship and the revolutions of the engine, or, in other words, the number of revolutions of the propeller and the space traversed by the ship in the same time.

The principle to which I have thought best to give the preference is that of the old and familiar chip log. It is in fact the one which gives the most simple and practicable arrangements, and it has the further advantage of giving absolute results; while patent logs with a small propeller towed behind the ship always require a standardization which may be modified by the slightest deformation. It was necessary, however, while preserving the principle, to modify the arrangements of the chip log in such manner as to relieve it of the disadvantages which render its practical use far from satisfactory.

The few square inches of the chip of this log give evidently too small an area to offer the necessary resistance to the log line. This restricted area seems to be imposed by the necessity of hauling in the log after each measurement. In order to avoid this serious inconvenience, the line has been replaced by a cord of low price and of known length, which is abandoned to the sea at each measurement. There is in consequence no further limit to the dimensions of the chip, except such as may be imposed by considerations of expense, or of the complication of necessary arrangements. These are, moreover, greatly decreased by the fact that in the method under consideration it is no longer necessary to throw the log every hour, as formerly, but only so frequently as new circumstances may arise susceptible of modifying the advance per revolution.

The chip of the log is replaced by a bag of cotton cloth attached to a ring of reed of about 16 inches diameter, and into which is thrown a handful of sand in order to prevent its being readily carried by the wind. This bag, from the mass of water which it contains, as well as from its size, presents sufficient resistance to constitute a very satisfactory fixed point.

The old method of reeling the line on a drum was also no longer to be considered as a possibility. The very considerable circumferential velocities which would now be required (25 feet per second for 15 knots and 33 feet per second for 20 knots) would inevitably break the line. For this reason the line is rolled in balls of 100 meters (328 feet) similar to those made for the trade, and each ball is enclosed in a compartment of a case, from which it escapes without resistance and without ever becoming entangled. Four such balls are employed, the first serving simply to allow the bag to float backward to a sufficient distance to remove it from the effect of the wake. By means of simple electrical arrangements, each of the other three inscribes on a band of paper, similar to that in a Morse recorder, the period required for unrolling. On the same band, and parallel with the indications of the log, the revolutions of the engine are similarly inscribed, so that when the operation is terminated the officer of the watch may readily count the revolutions during the unrolling of the three balls of 100 meters (328 feet) each.

The register is placed in the navigator's room convenient to the officer of the watch, who may likewise use its indications at will to assure himself that the engine is turning at the prescribed speed.

As regards accuracy, a large number of trials made with this log have shown an approximation within one per cent., a value quite sufficiently accurate for all requirements of navigation.

The same trials have shown that the arrangements for handling the cord are entirely satisfactory and adequate for the purposes required. The register first employed, however, gave some trouble and occasionally allowed a signal to escape. A new apparatus is soon to be given extended trials on two high-speed cruisers, and it is expected that full satisfaction on the latter point will be given.

* Translated for MARINE ENGINEERING from *Comptes Rendus*, May, 1903.

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METHODS OF SECURING WATER-TIGHTNESS OF PLATES AT CONDUIT AND TUBES.

BY GEORGE MCQUILKIN, JR.

When a plate is pierced by conduit or tubing it is generally required that the conduit or tubing shall be water-tight at the plate, and especially is this true in the case of a deck or a water-tight bulkhead. This requirement has developed a number of devices, an inspection of which will reveal the same principle, that of compressing packing externally on the conduit or plate. Each shipyard has its favorite type, and these, in addition to the shipowners' standards, make an attempt at standardization of this important fitting fruitless, and a composite fitting taken from those at the command of the writer would not appear to secure the most desirable fitting. No attempt has been made to secure all the types in use, but to illustrate a sufficient number in order to point out the variety, with the hope that some attention and thought will be brought to bear on this important but oft-neglected fitting.

To preserve the water-tightness of the compartments of a ship when the plates are pierced for the installation of conduit or tubing, the most simple and effective means would appear to be that of tapping the plate and threading the conduit into the plate. This would necessitate the use of unions, flanges, or right- and left-hand couplings when desired to make the conduit continuous, and in the use of such fittings precaution need be taken to make the joint water-tight externally. The additional expenditure of labor and fitting would appear to be unnecessary when the result can be secured by other means. This method would not be practical in a thin plate, for the plate would not have sufficient thickness to tap the number of threads necessary to secure the water-tightness of the conduit.

For pipes under internal pressure the method of flanging the pipe at the bulkhead or deck is in general use, but this method would not appear to be adaptable to conduit or tubes in which the protection desired is from external pressure. The stresses in a pipe under internal pressure are different from the case under consideration, where we may consider the only stresses that have any effect are those of the vibration or differences in position of the bulkheads or decks when the vessel is loaded and when the vessel is empty. Generally speaking, this stress is unimportant in the installation of conduit because of the latter's relatively small size and its installation near the fixed points of a plate.

The accompanying figures illustrate a number of appliances that are in use. Fig. 1 illustrates a plate into which the conduit is threaded. It will be seen that to continue the conduit, a coupling will be necessary, and that if the conduit has a standard taper thread the coupling must be threaded so as to fit that taper before it comes into contact with the plate, otherwise the threads will not fit and this will be likely to leak. This can be prevented by threading the conduit for a sufficient length to project through the plate, and then "cupping" the end of the coupling and filling the cupped portion with packing which is compressed by a half coupling for this purpose. This method can be installed in a space equal to the outside diameter of the coupling, and the hole in the plate will not equal the outside diameter of the conduit. It will be seen that if the conduit were to lead down the plate on the opposite side, this method would make necessary the offsetting of the conduit to bring it nearer the plate after it had pierced the plate, and that in the use of the larger sizes of conduit no little space would be required to make a bend to accomplish this.

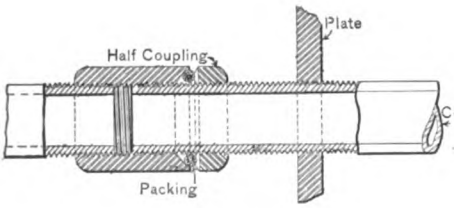

FIG. 1

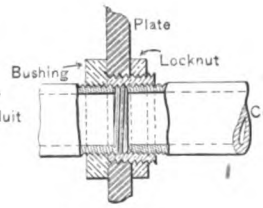

FIG. 2

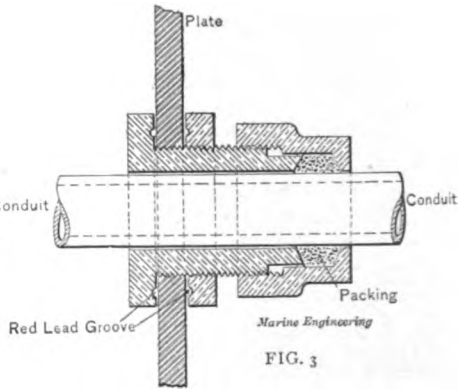

FIG. 3

Fig. 2 illustrates a method used for thin plates, the bushing being screwed into the plate and then clamped to the plate by a lock nut on one side, the grooves of the nut and the head of the bushing next to the plate being liberally treated with red lead. In this case the only precautions necessary are that the threads on the conduit are not too full and the threads on the bushing are tapped from both sides so as to have the proper taper. The greater surface of the bushing gives a bearing on the plate sufficient to make a water-tight joint, and the threading of the bushing into the plate serves to make a rigid connection to the plate. This method requires a space on the plate equal to 2 1-4 times the diameter of the conduit, and a hole in the plate equal to 1 3-4 times the diameter of the conduit.

Fig. 3 illustrates the principle of many devices used for this class of work, and consists of two lock nuts for compressing the packing against the plate on one or both sides, and a stuffing box to contain the packing which is compressed by a gland. This requires twice the diameter of the conduit for the hole in the plate, and a space 2.7 times the diameter of the conduit. A slight modification is made in this device by screwing one end of the conduit into the end of the box, the end in the packing end being cut off square. This admits of having a fixed point in the line and yet allows of the

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longitudinal movement of the conduit. Its length is greater than either of the above methods, and this is objectionable when it is desired to pierce the plate and turn at a right angle and run the conduit parallel to the plate.

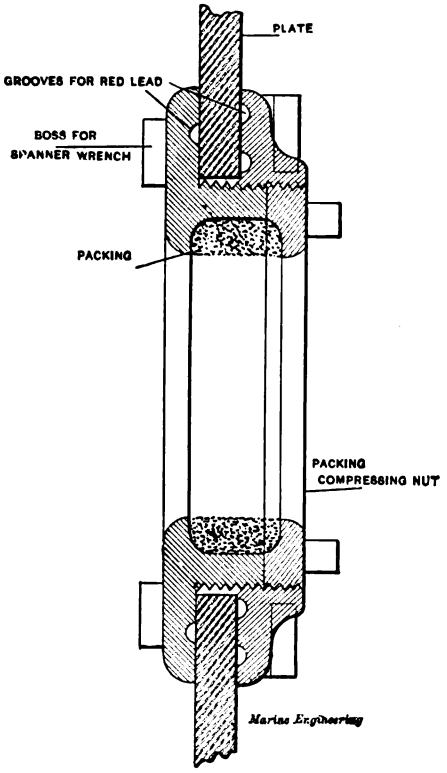

FIG. 4

Fig. 4 illustrates a device of size to admit of the packing occupying a space equal to the thickness of the plate plus the thickness of the two nuts on either side of the plate. This method also has the same objection as the two types previously described, in that there are two points of leakage exposed on each side of the plate, namely, at the plate and the nuts, and at the packing. Its size is out of proportion to the results gained, as the hole in the plate is about twice the diameter of the conduit, and the space required about three times the diameter of the conduit.

Fig. 5 is practically the same as Fig. 4, with the exception of the manner of forcing the gland down on the packing. It has the same objections as Fig. 4, and it also requires more longitudinal space for the studs for the packing-box nuts. It requires a space on the plate equal to about 3 1-4 times the diameter of the conduit, and a hole in the plate equal to about twice the diameter of the conduit.

Fig. 6 illustrates a device now used for the naval vessels, superseding an old method that has three exposed points of leakage and requires 2 1-2 feet of piston packing to fill the box. It requires a space on the plate equal to nearly twice the diameter of the conduit, and a hole in the plate equal to 1 1-2 times the diameter of the conduit. Its longitudinal length is greater in comparison with the similar types. Fig. 6, the naval type in use at present, has all the objections stated above. The packing in this type is of soft rubber, which rapidly deteriorates, especially when installed on plates exposed to temperatures above the normal. This feature requires attention and tends to making the device untrustworthy. The rubber gasket is usually fitted after the installing of the conduit, the gasket being split in the direction of its axis and slipped into place around the conduit. The compression of the gasket by the gland is not always sufficient to close the split in the gasket, the conduit is not exactly concentric with the stuffing box, and the removal of the gland for examination does not always reveal the true state of the gasket when under compression. This method requires a hole in the plate equal to nearly 1 1-2 times the diameter of the conduit, and a space nearly equal to 2 1-4 times the diameter of the conduit.

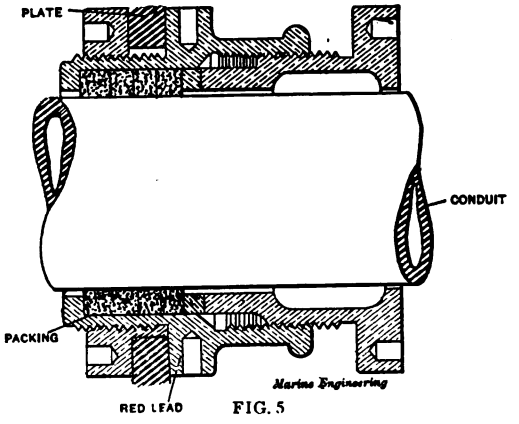

FIG. 5

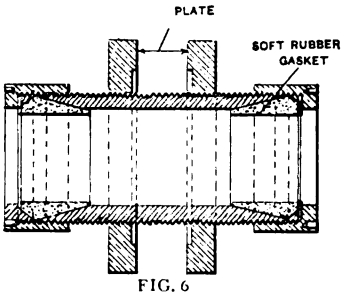

FIG. 6

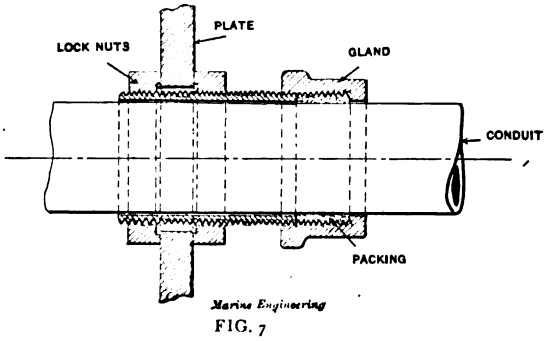

FIG. 7

Fig. 7 shows a device that has also been used to some extent on naval vessels. It has the same number of points exposed to leakage as the device above. A

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peculiar feature of this is that in order to use standard lock nuts and pipe caps (for the gland), the next largest size of these fittings for the alternate sizes of conduit requires two kinds of packing, 1-4-inch flax and corset-lace packing. That is, the 1-2-inch conduit would have 1-inch nuts and cap (gland) and use corset-lace packing; the 3-4-inch conduit would have 1 1-4 nuts and cap and use 1-4-inch flax packing; 1-inch conduit, 1 1-4-inch fittings and corset-lace packing, and so on. This device requires a hole in the plate equal to 1.3 diameters of the conduit, and a space equal to 1.6 diameters.

Fig. 8 shows a device that was designed to be fitted after the conduit was in place. It requires two bolt holes in the plate to clamp it to the plate and compress the packing. This type admits of a turn being made and the conduit being run parallel to the plate, but the objection to it is that the bolt holes are likely to leak, due to the working of the conduit or the plate, even though water-tight when first installed. This device requires a hole in the plate equal to the diameter of the conduit, and a space on the plate across the major axis and minor axis, respectively, equal to nearly 3.7 and 1.5.

Fig. 9 shows a device that is used when it is necessary to install a number of lines through a plate in a limited space—a condition that frequently occurs. This type necessitates the packing of the bolts in the plate, and care used when making the rubber packing for the conduits so that it fits very closely. The holes in the plate must have very little clearance or the rubber will be forced into a hole and will not make a satisfactory job. Numerous variations of this method are in use, the principal one being a plate of sufficient size to contain the necessary boxes with packing glands, fastened to the bulkhead by bolts or studs, the joint between the two being treated liberally with lead or packed with sheet rubber.

Fig. 10 shows a simple method that has a wider use than any of the devices described above. The simplicity of the parts and the ease of installing recommend it. It consists of threading the conduit for a few inches, or, as it is known, a "long screw," and with the liberal application of lead or the use of a grommet to make the joint between the plate and the nuts water-tight. In some cases a washer is used to secure more surface at the joint. A washer is always used when the joint has to be made on a wood deck, in order to prevent injury to the deck. In the latter case the best method would be to install the conduit before the deck is laid, making the joint at the plate, and when the deck is laid to calk the space between the deck and the conduit. In naval installations the nuts are made of composition or other soft metal, and a groove turned in the nut to form a recess for the lead or packing. The nut, being softer than the plate or the conduit, will, in every case where ordinary pressure is applied to tighten the nut, conform to slight inequalities of alignment. This method requires a hole in the plate equal to the diameter of the conduit, and a space on the plate equal to 1 1-2 times the diameter of the conduit. For continuous lines a half coupling, as described above, abuts the ordinary coupling to make that connection water-tight. The conduit may make a short turn on the plate after passing through, if the threads are cut full and the face of the elbow machined square so as to abut the nut, the whole being treated with lead.

The important features of the above devices are their weight and the ease of installing with respect to the degree of durable water-tightness secured. At a first glance the size and use of the fitting would not probably appear to justify any thought on their improvement, but if one considers the total number of fittings used on a single ship, as well as the numerous instances of piercing a plate with conduit or tubes, the fittings should not be ignored. The rapidly increasing number of conduit pipes and voice tubes necessary in the equipment of a modern vessel would seem to demand the standardization of these fittings for merchant vessels as well as for naval vessels, there being no difference in the results desired by their installations.

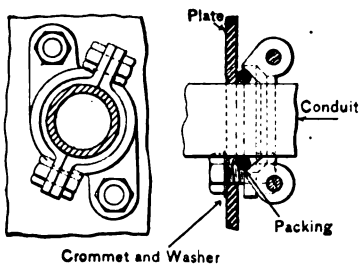

FIG. 8

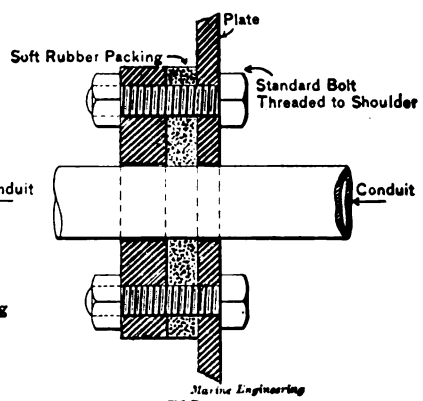

FIG. 9

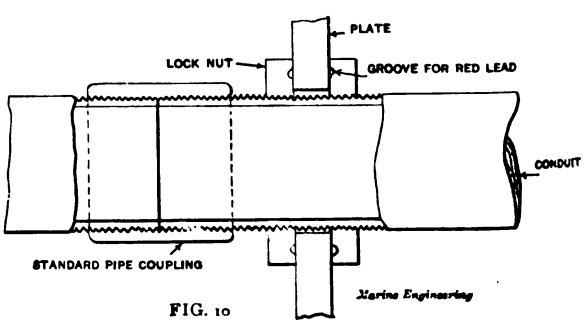

FIG. 10

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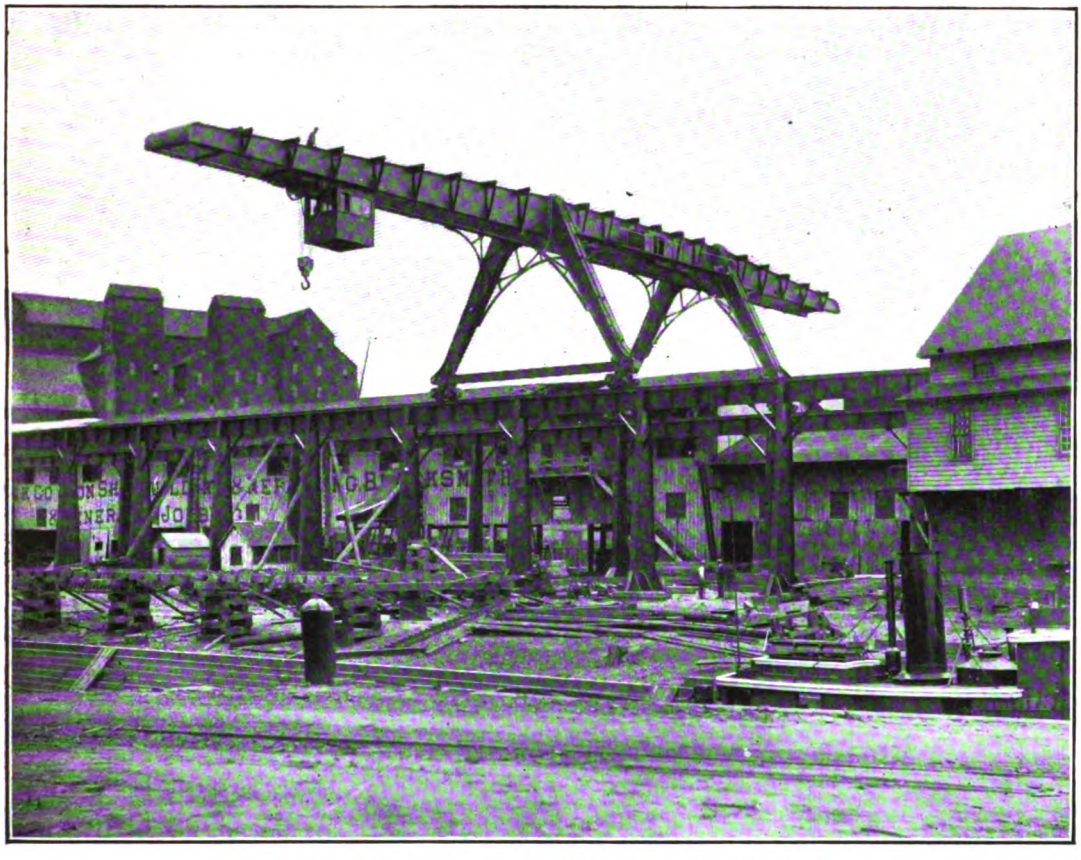
GANTRY CRANE OF THE BUFFALO DRY-DOCK COMPANY.

For the purpose of handling material at the Buffalo works of the American Shipbuilding Company, there has been built a large cantilever crane, as shown in the engravings. This crane travels on a steel runway made up of 17 bays, 24 feet centers each; thus the total length of the runway is 408 feet. The crane has a central span of 45 feet and a cantilever 73 feet long hanging over the building berth and extending out to the dry-dock. At the opposite end there is a 48-foot cantilever hanging over the ship shed.



THE 15-TON GANTRY CRANE OF THE BUFFALO DRY-DOCK COMPANY.

The crane consists of two girders thoroughly braced and tied together at their top flanges, and having rails rigidly connected to the inner bottom flange, upon which the trolley travels. These inner flanges are stiffly braced from springing outward. These girders, which are of single-web type, are supported on and rigidly connected to A-frames, the legs of which are built up of plates and angles to form a box section, and have their lower extremities rigidly connected together by heavy lattice channel I-beams. The girders are stiffly braced to the A-frames by neat circular knees, the knees being thoroughly braced and stiffened.

Under each of the legs of the A-frames are two wheel trucks, which consist of a heavy casting arranged in an equalizing joint so that the load is equally distributed on both the wheels. The wheels are of double-flange type, keyed to heavy steel axles and carried in bronze bearings provided with oil boxes, the arrangement being so that by the removal of two bolts the wheels, together with their bearings, may be taken out. The wheels on two of these trucks, one under each A-frame, are geared to a motor, carried on the side of the girders, by spur and bevel gearing and shafting. The bevel gearing is provided with thrust bearings and covered with sheet-iron casings. The trolley consists of a heavy steel framework, supporting the hoisting drum. The lifting tackle is made of extra pliable plough steel wire rope.

The lifting capacity of the crane is 15 tons throughout the length of the central span and the 48-foot cantilever, and to a position of 40 feet from the A-frame on the 73-foot cantilever, and a lifting capacity of 5 tons at the extremity of the 73-foot cantilever. With loads as noted above in their extreme position there is no tendency for the crane to overturn, but in case the 15-ton load were run to the extreme of the 73-foot cantilever, there are safety hooks arranged on the trucks engaging in the runway girder flange, so that there is no possibility of the crane being overturned. These safety hooks are placed only at the flange at the 48-foot cantilever end, as the crane would lift a 50 per cent. overload at the extreme end of this span without overturning the crane or lifting the trucks under the A-frame at the 73-foot cantilever end.

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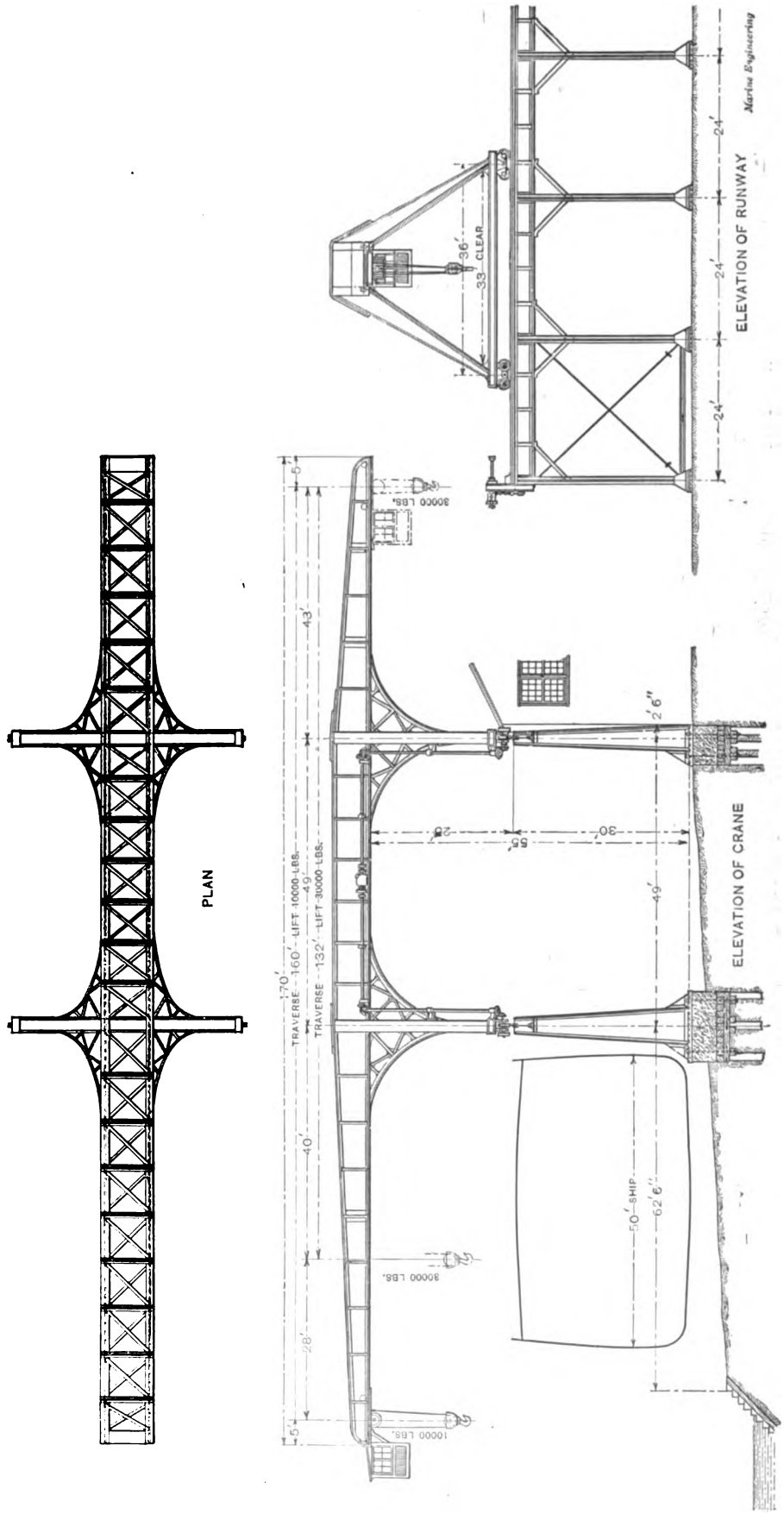

PLAN, ELEVATION, AND SECTION OF GANTRY CRANE AND RUNWAY BUILT BY THE WELLER-SKAVER ENGINEERING COMPANY FOR THE BUFFALO DRY-DOCK COMPANY.

The runways consist of single web girders having their top flanges thoroughly stiffened laterally by horizontal plate girders. These girders are supported on heavy columns spaced to suit the requirements of the yard. They consist of plate webs with heavy angle flanges, having very wide bases, which are thoroughly anchored to substantial concrete foundation piers carried on piles. At either end of the runway are placed buffers, consisting of heavy cylinders, having plungers with pistons working in oil, with conical rods working in openings in the piston, thereby producing the necessary retarding effect when struck by the crane, due to the carelessness of the operator or other accidents. The arrangement of the crane is such that the material may be taken from the ship and deposited in the yard under the central span for future use, or directly to the building berth, where it can be handled to its exact position on the ship. The long cantilever is of such a length that the material may be lifted direct from the scows in the dry-dock and carried to any point required.

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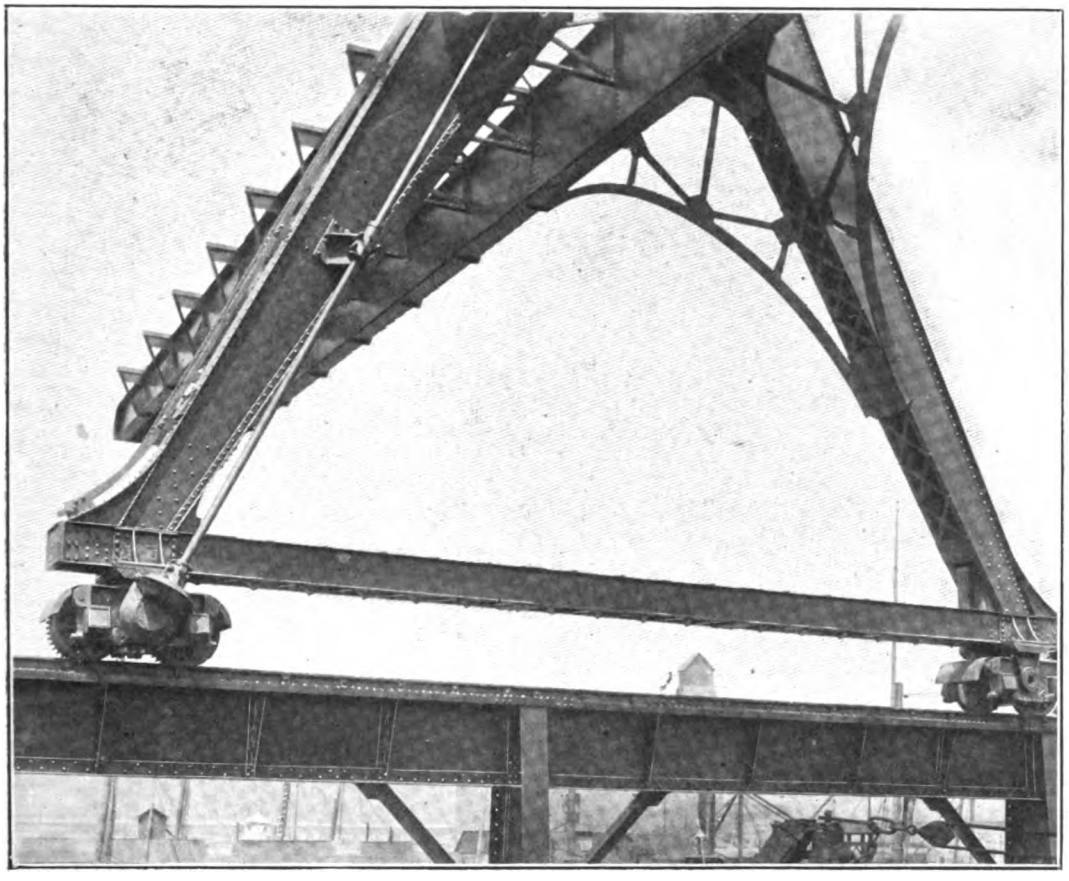
All the operations of the crane are controlled from the operator's cab, which is hung from and carried with the trolley, so that the operator always commands a full view of his work. The electric motors and other equipments are actuated by an alternating current and were installed by the Westinghouse Electric and Manufacturing Company.

The crane with its runways was built in the spring of 1898 and has been in constant use from that date. During this period of time it has received some very severe tests by lifting loads much in excess of its rated capacity.

The engineers and contractors for this crane service were the Wellman-Seaver Engineering Company, who designed and installed the service complete.



VIEW OF AN A-FRAME LEG, WHEELS, AND DETAIL OF GANTRY CRANE.

Fast Yacht.—On September 19 the Indian Harbor Yacht Club held a race for steam yachts. The race was for vessels of over 100 tons gross and between 100 and 150 feet on the water line. The race was won by Commodore Frank Tilford's *Norman.* According to reports she steamed over the 50 nautical mile course in 3 hours 1 minute and 29 seconds. The *Norman,* which was formerly the *Oneonta,* was designed by Gardner and Cox and built at the Delaware River Iron Shipbuilding and Engine Works. In 1901 she was rebuilt by the W. and A. Fletcher Company.

Modern German, English, and American Electric Launches.—III.

BY FRANK C. PERKINS.

Having already described briefly and illustrated some of the electric launches as built and used in Germany and England, we will now consider some of the latest designs of electric boats as constructed in America. One of the principal charging stations near New York, as well as the most noted electric boat-building plant in the United States, is that of The Electric Launch Company at Bayonne City, New Jersey.

It is acknowledged that the electric launch is the most desirable boat for pleasure, providing there are suitable charging stations available. It is claimed to be the safest of all forms of pleasure boats, as it cannot explode, carrying no inflammable fluid of any kind. When metallic air tanks are provided underneath the decks of sufficient size, the boat cannot sink, and the operation is most simple and can be controlled by any person who can steer a boat.

The motor is simple and noiseless, and is located under the flooring and direct-connected to the propeller shaft, while the batteries are grouped either beneath the flooring or under the seats. There is no odor, heat, noise, or smoke from these pleasure boats, and when the motor stops there is no expense of consuming fuel without doing any work.

The electric fishing boat is very desirable, as its noise-

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less electric power and ease of control are decidedly in its favor for this sport as well as hunting. In America the commercial building of electric launches was started about ten years ago, and at the World's Fair in Chicago 55 electric boats were in operation, each 36 feet in length and capable of seating 35 persons. These boats were given the most severe service, and an excellent opportunity was thus at hand for testing as to speed, strength, reliability, and satisfactory working of every electrical feature.

A popular type of electric launch is the 30-foot boat built for Robert P. Linderman, of South Bethlehem. Pa. This pleasure craft is fitted with long fly awning, cane chairs and other finely upholstered seats, and is operated on Long Island sound at Fisher's island. The boats may be charged from any direct-current plant of either 110, 220, or 500 volts, and the usual cost is 10 cents per Kw., or, for this size of craft, 20 to 40 cents per hour of charging. The time of charging is from three to five hours, according to the state of the batteries. These electric launches are provided with a switch which is fitted with spring contacts to hold a charging plug to which the service wires have been attached. By inserting this plug and closing the lever arm upward the circuit for charging is established. This switch has also a small key, or running plug, which closes the main circuit to the batteries, and when removed and carried by the owner the operation of the boat is absolutely prevented.

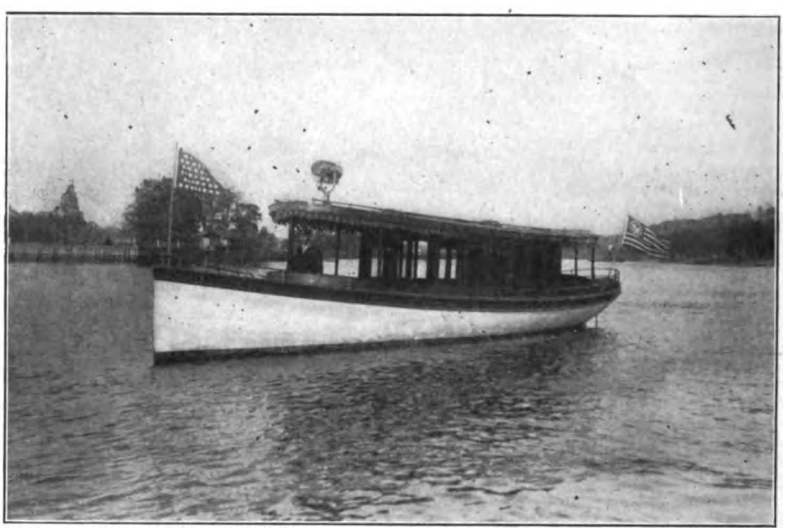
There are two neat electric launches on the Upper Saranac lake and Lake George, N. Y., one of which is 30 feet long and the other 36 feet long, the freeboards being 24 and 26 inches and the breadths 6 feet 4 inches and 6 feet 10 inches, respectively. These launches have a draft of 24 and 26 inches, and carry from 12 to 30 passengers at a speed of from 6 1-2 to 8 miles per hour. The radius of action is from 40 miles at a medium speed of 6 1-2 miles with a light battery, to 65 miles with larger, heavier cells.

On Schroon lake, N. Y., is an 18-foot electric boat specially built for hunting and fishing. It is noiseless at all speeds, and the motor is located under the rear seat and the batteries under the center seat. This boat has a beam of 4 feet 4 inches and a freeboard of 16 inches, with a draft of 16 inches. The motor is of the 1 1-2 horse-power enclosed type, water-tight, and propels the boat at about 5 1-2 miles per hour. It will carry from 4 to 6 persons comfortably, and has a radius of action of 25 miles at 4 1-2 mile rate with light cells of battery and 45 miles with the larger battery.

On Orchard lake, Mich., there has been in operation a 36-foot electric launch, of the low freeboard type and fast speed for lake and river service, known as the *Karuna*.

One of the most luxurious electric launches in use in the United States is the *Sovereign*, built by The Electric Launch Company of Bayonne City, N. J., for Mr. C. D. Borden, of New York. This electric boat has made a speed of 10 1-2 miles per hour over a measured course on the Shrewsbury river.

The electric cabin cruising yachts of 42, 54, and 63 feet lengths are equipped with batteries and motors capable of propelling the boats from 120 to 145 miles at medium-rate speeds of 8 1-2 to 9 1-2 miles per hour. These boats are very finely equipped with searchlight, and upholstered seats for from 30 to 70 passengers. The larger electric cabin cruising yacht has sleeping accommodations for four and a crew of two.



AMERICAN-BUILT ELECTRIC LAUNCH.

The 36-foot electric passenger boat in service on Central Park lakes in New York city has stored energy for intermittent or ferry service of 12 to 14 hours. The average speed of this boat is 6 to 8 miles per hour and it has a seating capacity of 40 passengers.

During the Pan-American Exposition the electric launches were a well-patronized feature of the exhibition and consisted of 11 30-foot boats. They were in service from May 15 to October 31 and carried 85,700 passengers, and it is remarkable to note that there was not one accident throughout the entire time, which is a good record for electric service of this character.

A still larger passenger boat propelled by electricity is the 42-foot launch operated by the Omaha and Council Bluffs Railway and Bridge Company, Iowa. This large electric boat will carry nearly 100 persons and has a seat-

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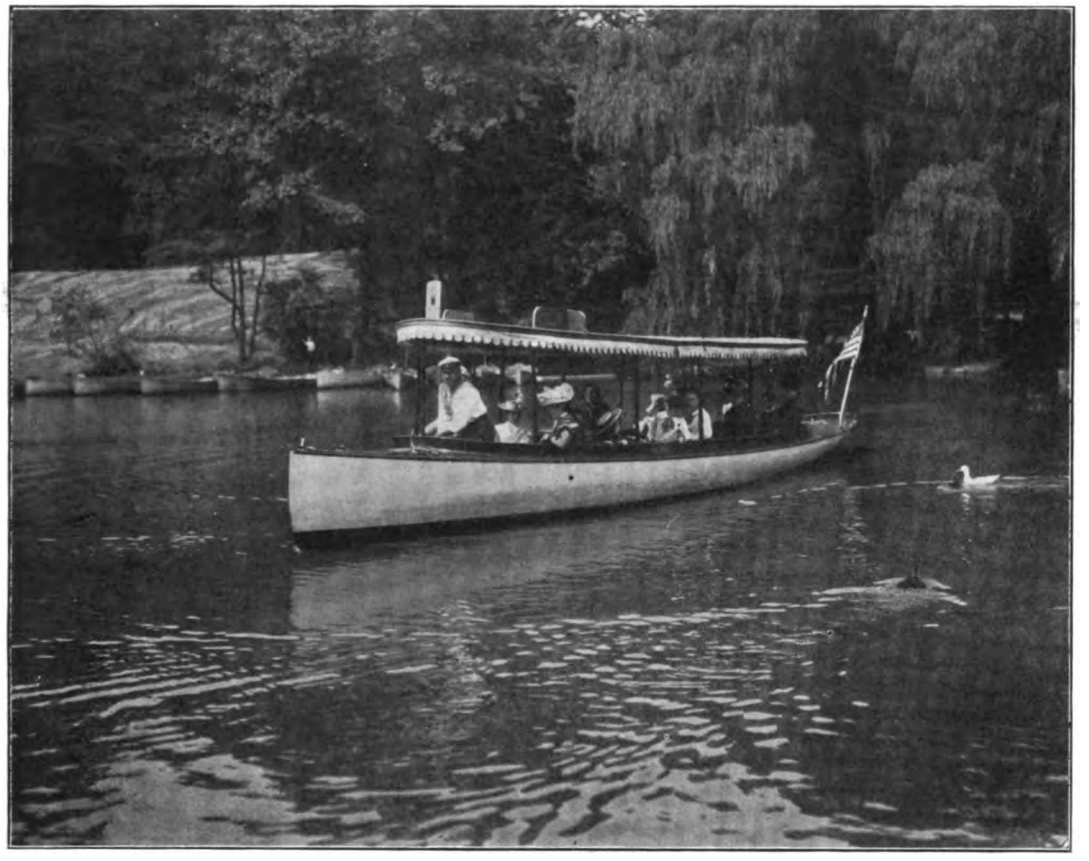
ing capacity for 70 adults. It is equipped with 44 storage cells of a special marine type, and has a radius of action of 75 miles at the medium rate of speed of 6 1-2 miles per hour with the heaviest set of batteries. It is 8 feet broad, draws 25 inches, and has a freeboard of 22 inches. It is operated by a 6 horse-power electric motor of the enclosed water-proof type, and is built with a standing roof with storm curtains.

A 30-foot electric gig or yacht tender was constructed several years ago in this country for the U. S. S. *New York*, but on completion was transferred to Grand Duke Alexander of Russia. Another, larger boat was built later for the *New York*, 31 feet long. These electric gigs are no heavier than those having steam or naphtha engines with their coal bins or their tanks filled. Each boat's equipment has a battery capacity for a continuous run of about 3 hours at full speed, or 5 to 6 hours at a little less speed, and it is capable of very high speed for short spurts. There is no loss of electricity when the motor is not running, and the gig will give intermittent service during several days before recharging is necessary. A full recharge requires from three to four hours. Each electric gig is supplied with voltmeter, which shows approaching exhaustion of the stored energy. The electric gig is instantly available after being lowered, and is a model of cleanliness and simplicity, with entire seating space free for passengers.



36-FOOT ELECTRIC LAUNCH USED ON CENTRAL PARK LAKES, NEW YORK, N. Y.

EVAPORATORS AND DISTILLERS.

BY W. W. EDWARDS.

The problem of securing fresh water at sea has been solved in various ways during the time that men have gone down to the sea in ships. In the earlier days of navigation, when wind was the only motive power, water was taken aboard in casks in sufficient quantities to last until land was again sighted, where the supply could be replenished. This somewhat precarious method fulfilled the requirements until the introduction of steam increased the demand for fresh water far beyond the available carrying capacity of the ship to supply. Engineers were therefore forced to turn their attention to the production of fresh water from the sea, and the result has been a class of apparatus known as evaporators, whose development makes an interesting study for the engineer.

It is known that when water boils, all impurities, except those that are easily volatilized, remain in the vessel, while the water in the form of vapor passes off into the atmosphere. In the case of an evaporator, if this vapor is collected and condensed, it is found that the resulting water is almost absolutely pure and in this state is much superior for boiler feed to any water obtainable ashore. The term "almost absolutely pure" is here used advisedly in view of the fact that chemically-pure water is a laboratory curiosity and is not the product of any evaporating plant aboard a ship, regard-

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less of any claims of interested parties to the contrary. As evaporation continues, more sea water is admitted to the evaporator to maintain the water level, and, as it brings its impurities with it, salt and other foreign matter continue to collect until this water holds five to eight times as much salt as does an equal volume of sea water. When this point is reached, the entire charge of highly concentrated brine is forced back into the sea and the vessel refilled.

The similarity of these operations, such as boiling the water to produce steam and blowing out the concentrated brine, to those that are practiced around the boilers of a ship, at once suggested the use of one of the main boilers as a producer of fresh water. Accordingly we find that, before evaporators were regularly manufactured and installed as part of a ship's equipment, either one of the main boilers or the donkey boiler was actually used for this purpose. The only attachment required, in addition to those fitted to the boiler for the generation of steam for power purposes, was that a separate line of piping should connect the boiler with the condenser. This method was followed for a time, and in some ships the donkey boiler is still used in this manner.

The disadvantages of the use of a boiler for distilling purposes are so great and so evident that it is only necessary to mention them. They are the loss of the boiler for power purposes, the great weight and space for the purpose that is served, the difficulty of close regulation, the care that must at all times be exercised, and the loss in fuel. To meet these objections the modern evaporator has been designed; and when it is considered that only about one-tenth of the space is occupied that the boiler requires, that the weight of the evaporator is a very small fraction of the weight of the boiler, that heating the water by means of steam coils is capable of the closest regulation by valves, and that the expense for fuel is greatly reduced, it is seen how completely the evaporator fulfills the purpose for which it is intended.

MODERN PLANTS.

A modern distilling plant is shown in Fig. 1. The evaporator, *A*, is seen to be cylindrical in form and is usually placed on the engine-room floor plates. Alongside the evaporator is placed the distiller, *B*, for the purpose of condensing the vapor from the evaporator. A word concerning the propriety of applying the term "distiller" to an apparatus whose sole purpose is the condensation of vapor, may not be out of place here. It is a term that has come into use by seagoing engineers in order to distinguish this apparatus from the main condenser. Properly speaking, however, distillation is the entire process of evaporating water and reconverting the resulting vapor into water again, and the term distiller should refer to the whole plant; but, for the reason mentioned above, it has only been applied to the condensing part of the plant.

It will be noticed that the vapor pipe, *P*, is first carried vertically upward and then over to the distiller. The reason for running the vapor pipe in this manner is to prevent any entrained water that may be present in the form of drops from being carried over into the distiller. The vertical direction of the vapor pipe tends to assist the return to the evaporator of all entrained water by the action of gravity. This is an important point to be observed in the installation of a distilling plant, as the entrained water is unevaporated and consequently contains all the impurities that are to be found in sea water. Any evaporator that primes will not make fresh water, and the successful operation of a distilling plant requires that the vapor from the evaporator shall be 100 per cent. dry steam. This is of so much importance that unusual designs are sometimes resorted to in order to obtain the vertical length of piping. On the United States cruiser *Chicago* the vapor pipe is carried about 25 feet from the evaporator platform up the engine-room hatchway and then back again to the former level to the distillers, in order to obtain the vertical length of piping. There are a great many installations of evaporators where no unusual efforts are made to run the vapor pipe vertically, but it is better to have the distiller on a higher level than the evaporator, and if the pipe has a vertical section the chance of making salt water is minimized.

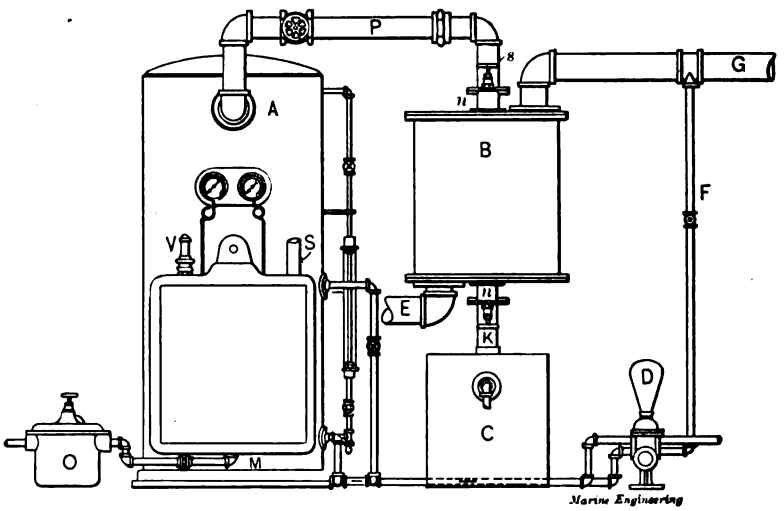

FIG. 1.

The vapor pipe is connected to a small fresh-water manifold, *n*, on the top of the distiller, *B*. This mani-

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fold is secured to the top head by means of tap bolts, and its purpose is to distribute the vapor from the pipe *P* to the ends of three condensing coils that are within the distiller shell. There are valves that fit over the ends of the condensing coils, whose valve stems, shown at *s*, extend through the top of the manifold. The purpose of these valves is to enable the engineer to cut out any one of the coils that may be leaking. A similar manifold with similar valves is fitted on the bottom head of the distiller, in order to collect the fresh water from the coils and discharge it through the pipe *K* into the receptacle below. The valves in the lower manifold are for the purpose of sealing the lower end of any coil that may be leaking salt water.

Connected to the upper part of the upper fresh-water manifold is a valve known as the aërator, the purpose of which is to admit air to the vapor before it is condensed. This valve is not shown in the figure. It operates as a check valve, opening inward, so as to prevent the escape of vapor should the pressure within the vapor pipe exceed that of the atmosphere. Owing to the condensation within the distiller coils, there is usually a partial vacuum in the vapor pipe near the distiller, and consequently air is taken in through the aërator. It is known, by those familiar with distilled water, that when water is perfectly pure it is most unpalatable and has a very bitter taste, and the reason that spring water is usually so sparkling and refreshing is

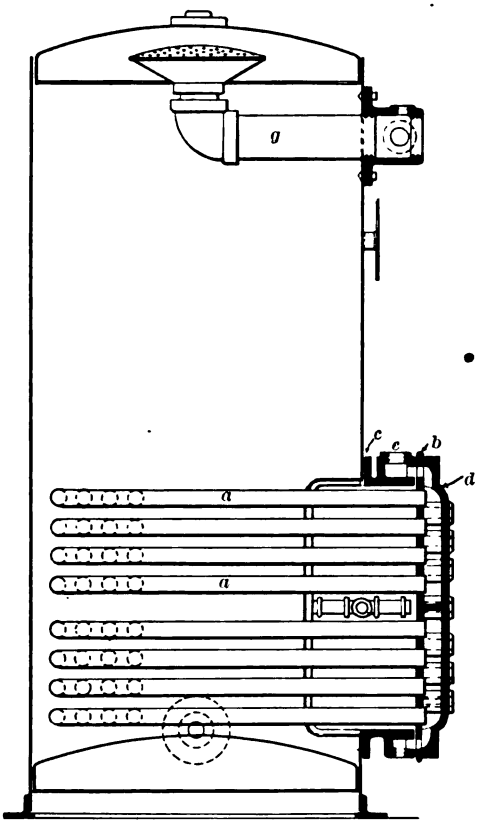

FIG. 2

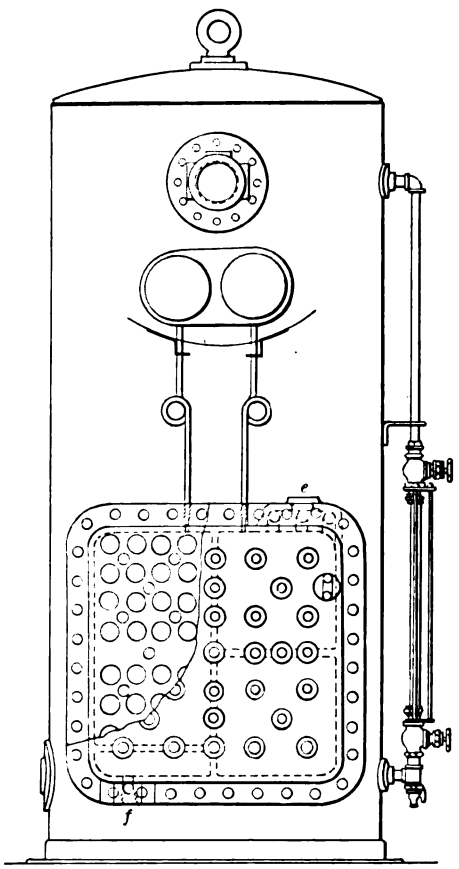

FIG. 4

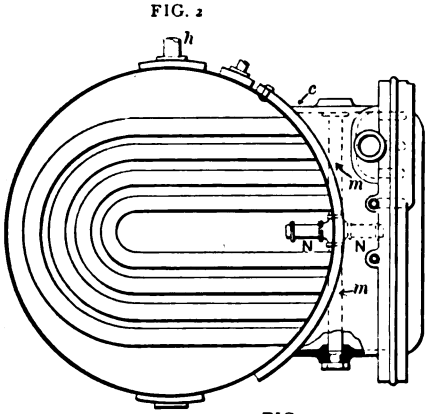

FIG. 3

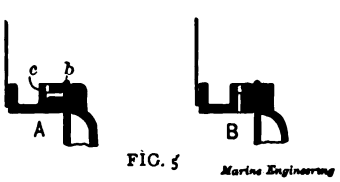

FIG. 5

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because of the air and other gases that have been absorbed by it during its passage through the earth. Some of the minerals contained in spring water are also well known to add to it refreshing qualities. Aërating the water tends to disguise the bitter taste and renders it much more agreeable when used.

The same purpose is served much more effectually by blowing air, by means of an air compressor, into the bottom of the fresh-water tanks when they are partially filled with distilled water. The bottoms of such tanks are made double, with the upper one perforated, and the air is blown in between the two bottoms and rises in small bubbles through the water.

Distilled water will absorb air by merely removing the manhole covers on the fresh-water tanks, and this will in time supply all the air that is needed to make the water agreeable to the taste. It is thus seen that the aërator is not an absolutely essential fitting to a distilling plant, as its function can be performed in other ways. The writer at one time had charge of the evaporators on the gunboat *Wilmington*, and cut out the aërator altogether for months at a time without injury to the water in any way. When the water first came from the distiller it was a trifle more bitter with the aërator closed than with it open, but by the time the water had been twenty-four hours in the fresh-water tanks the difference was imperceptible to the taste. The writer's opinion that the aërator is of doubtful utility has frequently been corroborated by men who have been engaged in the manufacture of evaporators for years.

At *C* is shown a filter, through which all the fresh water from the distiller must pass. It is usually fitted up in the interior with perforated trays on which are placed quantities of charcoal. While this receptacle is called a filter because of its similarity to filters used ashore, its real purpose is not to filter or purify the water, as distilled water needs no filtration, but rather to assist in its reabsorption of oxygen. It is a well-known fact in chemistry that charcoal will give up its oxygen to the water. This necessitates the renewal of the charcoal at intervals of about two months. The filter also serves as a reservoir to hold the water during any temporary stoppage of the fresh-water pump, and it also regulates any unevenness in the supply of water to the pump due to the rolling of the ship. The pipes connecting the filter to the other parts should have unions in them, in order to facilitate the removal of the filter while making repairs or renewing the charcoal.

The pumps required for an evaporator installation consist of a brine and feed pump, shown at *D*, and a circulating pump for the distiller. The brine and feed pump is direct-acting, with one piston rod and three cylinders. One cylinder (usually the middle one) is a steam cylinder for operating the pump, and the other cylinders are for feeding the evaporator and for pumping the concentrated brine overboard. It is sometimes the practice to use one end of this pump for pumping the fresh water into the storage tanks and to use the other end for both feeding purposes and removing the brine; the arrangement of the piping being such that this change can readily be made. A pump for removing the brine is not always installed, as it is possible to empty the evaporator overboard by blowing down under pressure or by allowing the brine to run into the bilge. There are objections to this, however, which will be discussed later, and the best practice is to install the brine pump.

The circulating pump is for the purpose of supplying the condensing water to the distiller, and almost any style of duplex pump is well suited for this purpose. This pump is not shown in Fig. 1, but the water enters the distiller through the pipe *E* and is discharged overboard through the pipe *G*. As the circulating water in the pipe *G* has had its temperature raised by the condensation of the vapor in the distiller, it is more economical to use this water for feeding the evaporator than water directly from overboard. Accordingly the feed-pump suction pipe is connected directly to the pipe *G*. As it is always necessary aboard a ship to have a pump running for sanitary purposes, it is usual to use this sanitary pump for the circulating pump of the evaporator plant, and where this is done the discharge from the distiller is connected to the flushing system of the ship. As the sanitary or flushing pump must run all the time, it is necessary to arrange by-pass piping around the distiller, in order to be able to cut out the distiller for repairs or during any interval when the evaporator may not be in operation.

Boiler steam, for the purpose of heating the water to be distilled, is passed through a reducing valve, set usually at 20 pounds, and enters the evaporator through the steam pipe *S*. The steam passes into the square head shown at the front of the evaporator, and from this head it enters the heating coils within the water space. As the steam gives up its heat to the water, it condenses and the water of condensation passes out through the drain pipe *M* to the steam trap *O*, which empties the water into the hot well. Fig. 1 shows the position of a safety valve, *V*, used on the heating coils, a water column for indicating the height of water within the shell, and two steam gauges for indicating the pressure of the steam in the coils and the vapor within the shell, respectively. Throughout this article the term vapor will apply to the steam arising from the salt water, to distinguish it from the boiler steam used for operating the evaporator. The general arrangement of a distilling plant as installed aboard a ship will be made evident from the foregoing description. It now remains to show the internal fittings of evaporators and distillers of leading makes, such as an engineer is liable to meet with in going aboard a ship.

SPECAL TYPES OF EVAPORATORS.

In Fig. 2 is shown an interior view of an evaporator manufactured by M. T. Davidson, of Brooklyn, N. Y. This evaporator is of the vertical type and is rated at a capacity of 1,500 gallons per twenty-four hours. The shell is made of boiler plate of 60,000 pounds tensile strength, and has a convex and a concave head at the top and bottom, respectively. This style of head is used because it obviates the necessity of internal braces. The heating coils, *a*, *a*, consist of U-tubes arranged in 8 layers with 4 tubes in each layer. (A plan view is shown in Fig. 3.) These tubes are expanded into a tube sheet, *b*, that fits over studs that are tapped into a casting, *c*, riveted to the evaporator shell. Over the same studs that hold the tube sheet there is placed a bonnet, *d*, so flanged that when the nuts on the studs

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are drawn up tightly there is a space of 3 or 4 inches between the tube sheet and bonnet at all points except around the outer edge and along ribs. These ribs, shown very plainly in the front view in Fig. 4, project from the outer bonnet against the tube sheet in such a manner as to divide the space between the tube sheet and bonnet into four unequal compartments. Gaskets are placed between the casting *c* and the tube sheet *b*, and between the tube sheet *b* and the bonnet *d*, in order to make steam-tight joints.

Steam from the boiler is admitted to the tubes through the opening *e* in the casting *c*. This leads the steam directly into the upper right-hand compartment framed by the ribs and the outside flange of the bonnet, as shown in Fig. 4. From this compartment the steam flows through the upper nest of the U-tubes into the large compartment on the left. From here the steam passes through the three upper layers of the lower nest of tubes into the compartment in the lower right-hand corner of Fig. 4. The steam and water of condensation

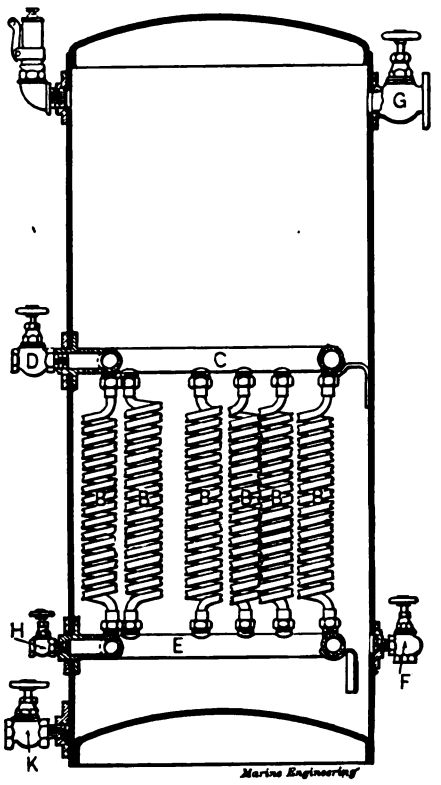

FIG. 6.

pass from this compartment through the lower right layer of tubes into the small compartment in the lower left-hand corner, and the water of condensation passes out of the evaporator at *f* into a steam trap. It will be noted that the entrance of steam at *e* and the drain *f* are both part of the casting *c*. This secures the very great advantage that it is not necessary to disturb any of the steam piping or drains when the heating coils are withdrawn for scaling.

The feed water is admitted to the evaporator through an internal feed pipe, shown at *m, m*, Fig. 3. This pipe extends across from side to side of the casting *c*, so that the external feed pipe can be connected to either side. The side that is not used can be easily closed with a pipe plug, as shown in Fig. 3. At the middle point of this cross pipe is placed a four-way fitting, so that two short pieces of pipe can be screwed in at right angles with the cross pipe. These short pieces are perforated with a large number of small holes, which tend to distribute the cold feed water instead of delivering it against the hot coils—an evidently important and desirable feature of feed-water distribution.

The two gauges are connected through casting *c*, the steam to the space between tube sheet and bonnet, and the vapor gauge to the space around the coils, as shown in Fig. 5. At *h*, Fig. 3, is shown the connection for the brine pump. This pipe should also have a connection directly to the sea, in order to blow down the evaporator under pressure whenever circumstances compel a resort to this method. The Davidson evaporators are also made with a horizontal shell to meet any requirements that restricted space may impose.

Another widely known evaporator is the Quiggins Patent Evaporator, manufactured by the James Reilly Repair and Supply Company, of New York. This evaporator is shown in cross section in Fig. 6. It is seen to consist of an upright cylindrical shell of boiler plate, with the upper head convex and the lower head concave in order to obviate the necessity of stays. There are two annular-shaped manifolds, *C* and *E*, in the interior, one about the middle of the shell and the other a few inches from the bottom. These manifolds are connected by a number of spirally-shaped coils, *B, B*. These coils are secured in place by means of unions, so that a defective coil can be removed and the openings capped or another coil put in place with only a few minutes' delay. This feature is a very valuable one, as a leaking coil can be repaired at the convenience of the engineer without causing a shut-down of the evaporator for a long period of time.

The evaporator coil is crescent-shaped. This shape has two advantages—viz., there is greater heating surface per unit volume of steam within the coils, and it is claimed that with this shape the coils are self-scaling because of the alternate expansion and contraction. Access to the interior of the shell is had by means of two manholes, one on a line with the lower manifold, *E*, and the other just above the manifold *C*.

The valve *F* is the feed-water valve through which the feed enters the evaporator; the valve *K* is the brine valve and is used for the removal of the concentrated brine. Boiler steam, usually reduced in pressure to 20 or 25 pounds, enters the heating coils through the valve *D* and manifold *C*, and when it has fulfilled its function and is condensed, it passes out of the evaporator through the drain valve *H* and a steam trap into the hot well.

When the vapor forms in the evaporator it passes out through the valve *G* to the distiller or main condenser, depending on whether the fresh water is to be used for drinking purposes or to make up losses in feed water. This evaporator is fitted with a safety valve, a steam gauge, a vapor gauge, water column, and other fittings necessary for its efficient operation.

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DISTILLERS.

The apparatus for condensing the vapor from the evaporator depends upon the principle of all condensers —namely, the absorption of the latent heat of the vapor by cooling water from the sea. The form of the apparatus employed varies somewhat in different types of distilling plants and makes an interesting study for the engineer.

The commonest form used with the Davidson distiller is shown in Fig. 1 at *B*. In the interior of this distiller are arranged three concentric coils of copper piping having their ends opening into the space underneath the manifolds *n*, *n*. At each end of the coil is a shoulder, and then a thread on the ends of the coil. These ends pass through holes in the heads of the distiller under the fresh-water bonnets, and a nut is screwed over the end of the coil to keep it in place. A gasket of sheet lead is usually placed between the shoulders and the heads, and also between the heads and the nuts on the ends of the coil, in order to insure that there shall be no leakage of salt water into the fresh-water vapor as it is being condensed. Many times has an evaporator been unjustly blamed for making salt water when the fault was altogether in the distiller coils. The distiller coils are made of copper and are usually lined with tin in order to prevent poisoning the water with copper.

Distiller coils, being of peculiar shape, are not readily purchased in all parts of the world, and a distiller that uses commoner forms of cooling surface, such as ordinary condenser tubes, would be much more easily and cheaply repaired when away from home ports. With the purpose of obviating the necessity of using coils, this company has designed the distiller shown in Fig. 7. It is seen to consist of a long and comparatively narrow cylinder containing condenser tubes, *c c*. These tubes are expanded into the tube sheet *a* at one end, and at the other end they are expanded into a header, *b*, that fits inside the end of the outer shell. The outer shell forms a stuffing box around the header *b*, and is packed with any good hydraulic packing. The packing is held in place by means of a gland and studs, as shown in the figure. The purpose of having the header *b* free to move through a stuffing box is to allow for the expansion and contraction of the tubes *c*, *c*. The circulating water enters at *f*, passes through the tubes *c*, *c*, and leaves the distiller at *g*, thus keeping the tubes cool and condensing the vapor. The vapor enters at *d*, and the fresh water leaves the distiller at *e*. The coolest circulating water meets the coolest condensed water and vapor, and as the circulating water becomes hotter it passes to that part of the distiller where it meets the hottest vapor. This insures a much more gradual transfer of heat from the vapor to the cooling water, and also insures a much greater efficiency of cooling surface than would be the case if the coldest circulating water met the hottest vapor.

It is usual to have the cooling water pass inside the tubes and the vapor outside; but this arrangement is sometimes reversed and the vapor is passed through the interior of the tubes with the circulating water outside. Either arrangement works well. This distiller can be placed in either a horizontal or vertical position. The pipe connecting at *f* must be so arranged as to yield sufficiently to allow for motion of the header *b*, due to the expansion and contraction of the tubes. As has been before stated, the great advantage of this form of distiller is the substitution of ordinary condenser tubes that can be obtained anywhere, for the copper coils that must be especially manufactured for distiller purposes. There is not sufficient demand for these coils to warrant a merchant in a foreign port carrying them in stock. Usually they must be made to order, which means delay and considerable expense.

The distilling apparatus that is used with the Quiggins evaporator is shown in Fig. 8. It is seen to be very similar to the evaporator, in that it consists of a cylindrical shell containing two annular manifolds connected by spiral coils of copper piping. The vapor from the evaporator is led into the upper manifold at the point *A*, and, after passing through the spiral coils, is discharged at the point *B* as fresh water. The circulating water enters the distiller at *C*, and, passing upward around the coils, condenses the vapor within them. The hot circulating water leaves the distiller at *D* and

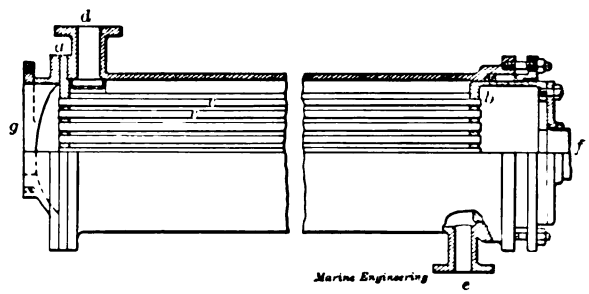

FIG. 7.

is discharged overboard. It will be noted that in this distiller also the hottest circulating water meets the hottest vapor. A great advantage of this type of distiller is that a defective coil can be readily removed by merely using a monkey wrench on the unions with which each coil is secured in place. The openings thus made into the manifolds can readily be capped and distillation proceeded with while the defective coil is being repaired.

EFFICIENCY OF PLANT.

The steam consumption of an evaporator is very nearly one pound of steam per pound of fresh water produced. This must be evident when it is considered that the total heat in a pound of steam is nearly constant, no matter what the pressure is, and consequently the heat in a pound of boiler steam would vaporize approximately one pound of the salt water. It is possible, however, to produce much more than one pound of fresh water per pound of boiler steam by having two or three evaporators connected in such a manner that the vapor from the first one is used within the heating coils of the second; the vapor from the second is used in the heating coils of a third evaporator. The drain from the heating coils of all the evaporators except the first should be discharged into the fresh-water tanks of the ship. This arrangement is called double or triple effect. It is necessary to use steam of comparatively high pressure

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in the coils of No. 1, so that the pressure of the vapor from No. 1 will be sufficiently high to operate No. 2. It is better to have an air pump connected to No. 3, in order to reduce the pressure within the shell so that evaporation will take place at a comparatively low temperature. By using three evaporators the following evaporative results have been attained with 100 pounds weight of boiler steam:

Fresh water from the heating coils of No. 2, about 90 pounds weight.

Fresh water from the heating coils of No. 3, about 87 pounds weight.

Fresh water condensed from the vapor of No. 3, about 88 pounds weight.

Therefore, allowing 15 pounds for loss by blowing off, from the use of 100 pounds of steam we obtain 250 pounds of fresh water.

HOW TO RUN AN EVAPORATOR.

In the distillation of sea water in an evaporator there

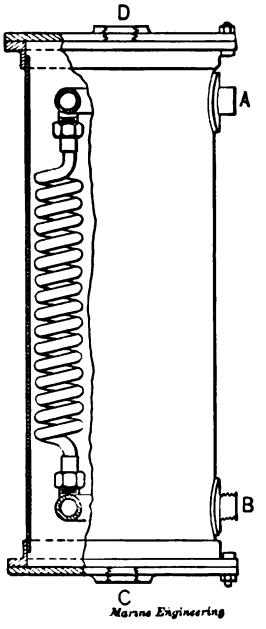

FIG. 8.

are certain rules and directions that should be followed in order to secure the best results. There is so little about an evaporator to get out of order that it will stand a great deal of abuse and still produce fresh water, but if the following directions are carefully observed the quantity of fresh water will be greatly increased and the work involved in keeping the evaporator free from scale, etc., will be greatly lessened.

The water level of the salt water in an evaporator should not be so high that all the coils are submerged. The reason for this is that the heating surface above the water level tends to dry the steam by vaporizing all the particles of water held in suspension. It is absolutely essential for the successful operation of a distilling plant that the vapor be dry before it leaves the evaporator, because the entrained water is as impure as the water around the coils. In the Quiggins evaporator nearly one-half of the heating surface is above the water level, and in the Davidson evaporator the top row of tubes is uncovered.

When the water level in the evaporator is at the right height, the circulating water should be started through the distiller, the valve on the steam pipe should be opened and steam from the boiler allowed to pass through the coils; the reducing valve having previously been set at from 15 to 20 pounds. As the evaporator and the water are both cold, it will save time if the by-pass valve on the drain pipe is opened and kept open until the water within the evaporator begins to give off vapor. It can then be closed and the normal working of the trap will keep the coils free from water of condensation. The valve in the vapor pipe should be kept closed until there is a pressure of 8 or 10 pounds on the evaporator shell, when it should be slowly opened and the vapor allowed to pass into the distiller. In opening the valve in the vapor pipe, care should be exercised that it is not opened so widely that the pressure of the vapor in the shell is rapidly reduced. Inattention to this precaution is almost certain to cause priming and the production of salt water instead of fresh water at the distiller.

The water from the distiller, when the evaporator is first started, usually shows the presence of salt and should therefore be allowed to run into the bilges, or, preferably, into the hot well, as it has, undoubtedly, less salt in it than the water in the boilers. This should be continued until the water, when tested with a solution of nitrate of silver ($AgNO_3$), shows perfectly clear in a glass when held up to the light. The nitrate of silver test is a very delicate one and indicates the presence of the slightest trace of the chlorides, such as common salt—sodium chloride.

When the water is clear after being tested, it should be run into the fresh-water tanks. The speed of the feed pump should now be regulated so as to maintain the water level constant, and the evaporator will run with very little attention from the engineer until the end of the watch, when it should be emptied of the concentrated brine in order to prevent salt from being deposited within the shell. It is unsafe to allow a higher degree of concentration than 5-32.

BLOWING OFF AND CLEANING.

The brine in the evaporator may be gotten out by pumping or by blowing out under pressure. Unquestionably the most convenient way is to open the bottom blow valve and permit the pressure within the evaporator to force the water out into the sea; but this method is open to the very great objection that it greatly increases the amount of scale on the heating coils. An analysis of the scale on evaporator coils shows it to be composed almost entirely of carbonate of lime, and consequently it is to the characteristics of this impurity of sea water that we must look for the explanation of the increased deposit of scale when the evaporator is blown down. Carbonate of lime begins to be precipitated at a temperature of 170 degrees Fahrenheit, and this process is complete at a temperature of 212 degrees, corresponding to a pressure of 15 pounds absolute. It is thus seen that the temperature within the evaporator is sufficiently high to precipitate the carbonate of lime. The bottom of the evaporator and the coils are covered with a soft white mud which may be easily washed out, provided it is not allowed to

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become baked, as would be the case if the evaporator were emptied while it was still hot. The most approved method of removing the brine is to shut off the steam from the coils, and, while the feed pump is kept running, start the brine pump. When the evaporator has been cooled by this method the feed pump may be stopped while the brine pump empties the evaporator.

The principal ingredient of boiler scale on seagoing vessels is sulphate of lime, but of evaporator scale it is the carbonate of lime. The difference is due to the fact that only an exceedingly small proportion of the sulphate of lime that is present in sea water is precipitated until the temperature of the water is about 290 degrees, which corresponds to a pressure of 45 pounds gauge. As this pressure is never approached in the evaporator, there is comparatively little sulphate of lime deposited.

The best time for removing the concentrated brine from the evaporator is when first going on watch. It is usual for the fire-room watch to clean fires when first coming down to the fire room, and consequently the supply of steam always falls off some at that time. By emptying the evaporator at the same time, the demand for steam is reduced and thus the fluctuation in the steam pressure is lessened.

In spite of the greatest care in operating the evaporator, it is sooner or later necessary to remove the deposited scale by mechanical means. In the Davidson evaporator the entire nest of tubes is withdrawn from the evaporator and the scale knocked off by means of scaling hammers and chisel bars. The Quiggins evaporator may be scaled by removing the manhole plates in the shell and tapping the coils with a scaling hammer. The scale must afterward be removed from the bottom of the evaporator; care must always be exercised that the coils are not caused to leak.

It is always well to test the tubes of an evaporator after scaling, in order to be sure that there are no holes in them through which boiler steam can pass. The tubes may be tested by turning steam on the coils before the evaporator is closed up and passing a lighted candle along them. If there are any holes the steam issuing therefrom will at once extinguish the candle. When the evaporator is working and a leak develops in the heating coils, its presence is usually attested by the water from the distiller showing salty when tested with silver nitrate. This is caused by the violent ebullition in the vicinity of the leak. The presence of the leak is further shown by a loud, rumbling noise coming from within the evaporator, by the fact that the water in the evaporator is heated much more quickly than usual, and also by the fact that the fresh water has a peculiar "steamy" taste.

Turbines for Cunard Line.—It is reported from the other side that the British Admiralty, at the suggestion of Lord Inverclyde, has decided to join the Cunard Steamship Company in its inquiry concerning the advisability of using steam turbines for the two proposed new ships. The committee of investigation consists of Admiral Oran, deputy engineer and chief; Lieutenant-Engineer Wood, acting as secretary; Mr. J. Bain, chief manager of the Cunard Company; Mr. J. T. Milton, the engineering surveyor of Lloyd's Registry; Mr. H. Brock, of Denny's; Mr. Andrew Lang, of the Wallsend; and Mr. T. Bell, of Clydebank Works.

Coaching Steam Launch Moguntia with Petroleum Fuel.*

In May, 1902, under the auspices of the Mainzer Rowing Association, a steam coaching launch was placed in service, regarding the trials and performance of which more extended accounts have recently become available, and which will have the highest value for all interested in boats of this character.

The hull is constructed of galvanized steel, with a length of 36 feet, maximum width of 6.9 feet, and a maximum draft forward of 1.64 feet. Aft, where the greatest width is attained, the boat rests quite flat on the surface of the water. The displacement of the boat cleared for trial, and including fuel for 12 hours full-power run, is 3.8 tons.

The peculiar form of the boat (so-called tetraedral), according to the patents of Naval Constructor Kretschmer, of the German Navy, is entirely new and seems destined to show itself peculiarly adapted to high speed, since, under the highest speeds reached, there is no pronounced bow wave nor settling of the stern.

The trials were carried out on the Zurichsee and on the Rhine, and for a one-hour test a speed of 13.4 knots with natural draft was reached, and with forced draft a speed of 14 knots. Such speeds have scarcely before been reached by a boat of like displacement.

For the Mainzer Rowing Club it was laid down as a primary and most important requisite that the boat should be able to follow the fastest eight-oared shell without forcing the engine or without, even at the highest speeds, disturbing the oarsmen by waves or water disturbance. It was also required that the boat should be able to turn quickly and rapidly in a narrow channel and that her general maneuvering qualities should be the best possible. Slow speed, and stopping with an assured spring forward or backward on signal, were also laid down as prime requisites for the special purposes of the boat.

The water lines of the boat are almost straight, and the entrance angle at the bow is not more than half that of a boat of similar length and beam but of ordinary form. The sharp angle of the water lines and the straight lead of the lines along the entire boat determine the small wave formation and the small loss of power, due to the fact that the stream lines are not required, as in the more common form, to follow a line of continuously changing direction. Under the flat, broad run of the boat at the stern the run of the water to the propeller is entirely free and undisturbed. The turning power and operation of the rudder is, due to the absence of the deadwood, especially energetic, and the boat is thereby able to turn in a circle of some two boat lengths.

The boat also backs especially well, and obeys the rudder like a side-wheel steamer; while, for boats of the ordinary form, the action of the propeller in backing usually causes a deviation from the desired course. In spite of the great sharpness of the water lines, the boat, with its 36 feet length, has a maximum breadth of 6.9 feet, greater than would be possible with such a boat of the ordinary form of like sharpness, and a considerable increase of water-line area is thereby

* Translated for Marine Engineering from *Zeitschrift des Mitteleuropäischen Motorwagen Verein.*

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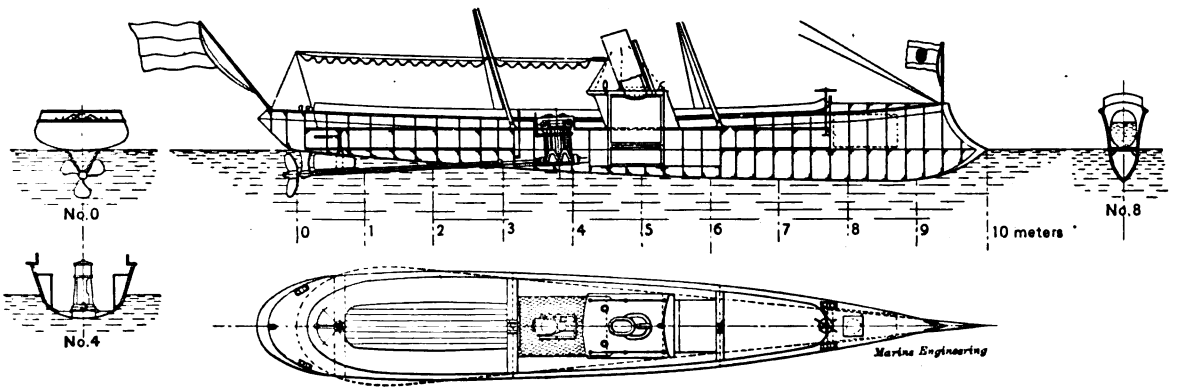
realized. This naturally gives for so small a craft a most unusual degree of stability. This again makes possible the provision of a wide, roomy space for coaches and passengers. Again, through the great breadth of the after body, the boat has been shown to possess a very satisfactory stiffness and reserve displacement, even under the powerful side thrust of the rudder when executing a sharp turn, under the full power of about 35 I. H. P. Due to the peculiarities of form, furthermore, even at the highest speeds there is manifest no disturbance to the crews in rowing, and, especially in smooth water, but the slightest lifting of the bow. The need which often exists with boats of the usual form, of using bilge or rolling keels in order to give sufficient steadiness in rough water, was here entirely absent. The stem is given a sharp slope aft, thus forming a ram bow. This is in order to give to the deck lines and to the form above water greater fullness of form, so that in rough water there would be provided a sufficient reserve displacement forward, and the fuel-oil tanks and heavy anchor gear here located would be given ample support. The upper forward deck is of galvanized steel, well elevated, and given the rounded form of a whaleback. The space for passengers or coaches is furthermore protected by an ample washboard extending around the cockpit and above the deck level.

The motive power consists of a steam engine, compound system, with automatic lubrication. The boiler feed, and the supply of fuel in the form of petroleum oil, are both likewise automatic. The regulation and manipulation of the engine are carried out by the usual regulating gear in the simplest possible fashion. The relatively small boiler is of a special patented system, with easily removable copper tubes, so that a degree of safety and simplicity is attained hitherto scarcely possible of realization under like conditions. The combustion in the furnaces is so complete and well regulated that a noiseless, odorless flame is produced, susceptible of control to meet all conditions. The arrangement of the grate is such, furthermore, that in a short time it may be adapted for the use of wood, coal, or coke, as occasion might arise. The boiler may be fired up and full steam raised in 12 to 15 minutes, and then the engine, with its automatic features, is ready for use with but slight further attention.

The construction of the hull of the boat, notwithstanding the lightness of scantling, is very strong and stiff, and even under full steam no vibrations whatever are perceptible. It was especially important, in the construction of the boat, to give ample strength and solidity to the phosphor-bronze shaft bearings and supports under the stern, since vibration due to weakness in this important structural feature might bring into question the results of this first example of the "tetraedral" form of under-water body for ships. The design was, therefore, most carefully arranged so as to provide for a substantially continuous and connected structure, from the engine foundation to the propeller, along the flat bottom of the after body of the boat. If such part of the structure is not made sufficiently strong at first, later stiffening is usually of slight avail. With the flat after-body form of the "tetraedral" model it is a most important requirement that this part of the structure be made as light and at the same time as strong and stiff as possible. Furthermore, the center of gravity of the ship, together with the machinery, must be most carefully computed by the constructor, in order that the boat may have the proper and desired trim.



A GERMAN STEAM LAUNCH, PETROLEUM FUEL, USED FOR COACHING.

This craft, so successfully built by Escher, Wyss and Company, Zurich, may be properly considered as a most notable advance in the field of high-speed craft for sport and pleasure.

Quarterly Shipbuilding Returns.—The Bureau of Navigation reports 310 sail and steam vessels of 66,023 gross tons built in the United States and officially numbered during the quarter ended September 30, 1903. During the corresponding quarter ended September 30, 1902, 348 sail and steam vessels of 103,42: gross tons were built in the United States and officially numbered. The wooden sail tonnage decreased from 24,410 to 12,437 gross tons, while the wooden steam tonnage showed an increase from 7,769 tons to 13,729 tons. The falling off in steel sail tonnage is most marked. In 1902 for this quarter there were built two vessels of 5,258 gross tons, while this year there was but one of 3,248 tons. The tonnage of steam steel vessels has shrunk from 65,948 to 36,609, there being a shrinkage on the Atlantic and Gulf coast of from 37,306 tons to 2,208 tons, while on the Lakes there was a slight increase. No steel vessels were registered as built on Western rivers during this quarter.

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THE SHIPPING QUESTION.

Desiring to secure opinions on the most suitable methods for restoring our prestige on the high seas, a prestige which, while once glorious, is now disgraced, Marine Engineering wrote to men prominent in the shipping and shipbuilding industries throughout the United States, asking for an expression of their opinion on this subject. From the many letters received, the preponderance of opinion is in favor of discriminating duties, and the following selections from the letters have been made as expressing the general sentiment.

No. 1.—*Great Northern Railway Company, New York, N. Y.*

Replying to your recent letter, I beg to say that the first thing necessary to build up the American merchant marine is to create a desire on the part of American merchants or capitalists to invest their money in ships. On the Great Lakes there is abundant business for ships, and the commercial necessities have created the demand. On the high seas experience has shown entirely different results. It is my judgment that no bonus or government aid will create an American merchant marine in opposition to those of foreign countries. Until the whole question is intelligently considered, and the conditions under which American ships meet those of foreign countries are made more nearly equal, there will be no success in building up the American merchant marine.

The United States has built up a system of railway transportation under which the public is served at an average of one-half the rates charged in Europe for like service, and this is done while wages are very much higher.

James J. Hill.

No. 2.—*The Delaware River Iron Shipbuilding and Engine Works, Chester, Pa.*

Replying to your inquiry, I believe that the merchant marine of the United States is entitled to the same protection that our other industries are; these industries are protected by tariff, and if something could be devised to give American ships an advantage in the American sea trade, the result would be an important increase and revival of interest in our shipping.

I think that probably the best plan that could be devised is the one of preferential duties, or a rebate of goods carried in American bottoms. This was done in the early days when American ships carried 80 or 90 per cent. of our shipments; and I believe that some similar plan which would not involve us in commercial wars with other powers would work out very satisfactorily in the present emergency.

The extension of our navigation laws to the Philippine islands would also be a step which would result in important increases in our carrying trade. No other power could object to the regulation which already is in force between coastwise ports; and as the Philippine islands are a part of our territory, there is no reason why the same laws should not apply to them. This would give us at once a large and profitable trade, and be the means of employing many American sailors and American ships. If we are to have any general industrial depression, the question of finding employment for our people will be an important one, and the greatest opportunity now open in this direction is on the sea.

John B. Roach, President.

No. 3.—*The Harlan and Hollingsworth Company, Wilmington, Del.*

In reply to your letter relative to steps to be taken toward building up the merchant marine of the United States, I write to say that, having had experience in the management of ships sailing under foreign and American flags, in my judgment the only way to assist to build up the American merchant marine is by direct subsidy. American owners cannot operate vessels with a handicap of 75 per cent. more wages to officers and crews manning these vessels, which is about the prevailing rate at present, unless the government will reimburse the owners to this extent.

There should also be a bounty tax paid to the builders for tonnage for the foreign trade, so as to put the prime cost of such vessels on an equality with the foreigners.

David C. Reid, President.

No. 4.—*Eastern Shipbuilding Company, New London, Conn.*

Replying to your communication relative to my opinion as to what is needed to build up the merchant marine of the United States, we certainly need assistance in some form to put us on an equal footing with the rest of the world; but, in whatever form this may come, it should be based upon American-built vessels, as it would be much better to let matters remain as they are than to pass any bill that would subsidize or admit to American registry foreign-built vessels.

Certain people have made it appear that the various ship-subsidy bills offered at different times have been for the interest of American shipbuilders and the building up of the merchant marine. In my mind, there never was a statement further from the truth; and I believe if any of the bills, previous to the one before the last Congress, had been enacted in law, the shipbuilding interests of this country would have been ruined for years to come. The shipbuilders of this country at the present time are in a most demoralized condition. This is owing to various causes, principally the increased cost of material, the increased cost and unrest of labor, and the inability of the builders of this country to compete successfully for tonnage in the foreign trade.

I believe that a subsidy bill should be based upon the amount of our exports (per tons carried per mile), and thereby the benefits would reach the farmer and all kinds of business.

Most every one is aware of the strides Germany has made in shipbuilding within the last few years. Some ten years ago Great Britain built ships for the Germans at a price equal to about 70 per cent. of that required by German builders. Now the Germans take orders in direct competition with the British, and are building equal, if not superior, vessels.

If some of our subsidy bills had been enacted in law, Great Britain would have been able—and, no doubt, pleased—to dispose of many of her old, slow, and obsolete vessels to this country, and replace same with modern, rapid, and up-to-date vessels; and it is easy

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to see the disadvantages we would be under if we should obtain these obsolete vessels. Great Britain and Germany, having superior vessels, would, of course, have the preference of both freight and passenger traffic.

Steel material entering into the construction of a vessel (providing this vessel is engaged in foreign trade) is now admitted free of duty. It would be quite beneficial to the shipbuilding industry of this country to have this extended so it would apply to vessels for the domestic as well as foreign trade.

It seems to me that protective duty on steel material is not needed, as our steel manufacturers are more than able to successfully compete with the British, and have sold steel in England in the past for about two-thirds the price that they then asked for it in this country. The public press, within the last few months, has shown that steel can be produced much cheaper in this country than in Great Britain. What we need is a subsidy bill which will give a small bounty on our exports, based upon tons of freight per mile carried in American-built vessels, and, to further assist, remove the duty upon steel and coal. I am a protectionist, but believe, when an article can be produced in this country cheaper than it can be elsewhere, that it is inconsistent to have a protective duty governing same.

C. R. HANSCOM, President.

No. 5.—*Fore River Ship and Engine Company, Quincy, Mass.*

You ask me to state "as specifically as possible what action, in my mind, is most necessary to give the United States a merchant marine in keeping with its dignity and commercial importance."

I heartily agree with you as to the vital importance of doing something at once to build up our merchant marine. We must acknowledge with humiliation that our great nation has been whipped from the high seas by the superior foresight of other governments; and for this reason there are not in America to-day enough shipyards for skilled shipbuilding workmen to build the ships that are needed for the United States Navy with anything like the speed necessary, nor enough American sailors to man them when they are built.

The cause of this is evident enough; for, suppose any one of our industries protected by tariff should be exposed to foreign competition by repeal of the duty on its product, that industry would be wiped out in short order, and other industries connected with the vanishing industry would suffer also.

Furthermore, if, in addition to our lack of protection of such industry by tariff, a foreign government desired to encourage that particular industry and should subsidize it, the case of our unprotected industry would be absolutely hopeless.

This is the condition to-day of American shipbuilding and American shipowning. The building and operating of deep-sea vessels are unprotected industries which are obliged to pay the wages of our highly-protected country; and, in addition to this lack of protection, these shipping industries are and have been struggling against foreign competitors who are made strong by government help. The wonder is, not that shipbuilding and our merchant marine are at such a low ebb, but that there is anything left of them.

Coastwise ship building and owning is protected and fairly prosperous, but the busy lines of traffic in our country run east and west, and our north and south coast lines are not in line with this great current; besides this, the "maritime habit" is broken in the United States by long years of adversity; American labor is not being educated along this line; capital, discouraged and driven from the deep sea, is not attracted to coastwise shipping investments; and the shipyards on our seacoasts, though few in number, supply more building capacity than the coastwise trade can find use for, and so are obliged to depend on the uncertain business of building naval vessels to keep them going.

As to the remedy, unless Yankee ingenuity can find some method that has not yet been suggested, we must use the same weapons that England has used to drive us off the sea, *i.e.*, government encouragement. This must come through discriminating duties or subsidies; and, in my opinion, a wise combination of both duty and subsidy is needed to bring that immediate and rapid improvement that the acuteness of the situation demands.

THOMAS A. WATSON, President.

No. 6.—*The Johnson Iron Works, New Orleans, La.*

In reply to your letter inviting expression of my views on the question of "building up our merchant marine," I beg to say that advisory comment upon the problem, to have any value, should be based upon a much more profound knowledge of its factors than I possess; but even a layman would recognize that, so long as the cost of a fully-equipped steamer or sailing vessel plays important part in figuring the results of its operation, the country building the cheapest ships, other things being equal, will own and operate the largest marine fleet, where competition is on a commercial basis free from government aid.

We cannot build ships in this country as cheaply as is done abroad, owing to the cost of labor employed in the home industry; nor is it practicable, in my opinion, to ever obtain the skilled and common labor used in shipbuilding in this country at a parity as to cost in foreign countries; nor is it desirable, even if possible of accomplishment.

It may then be accepted as a substantial fact that the most energetic and enterprising people of the age are behind their foreign neighbors in the ownership and operation of so important a thing as a merchant marine, because of the comparatively excessive cost of a home-built vessel and the prohibitory governmental restrictions attached to the purchase and operation of foreign-built vessels. The shipowner is ready to increase his holdings, and others are ready to become shipowners, if an American-built vessel can be bought as cheaply as one of foreign build, or the excess in cost be made good to him by governmental warranty of profitable patronage or aid.

As it is impracticable for the home shipbuilder to compete with the foreign rival in the cost of construction, it would seem that the only remedy capable of meeting the situation must be of governmental origin. So far, a layman may logically proceed without risk

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of committing grave error in review of the conditions that stand as a bar to development of our merchant marine, and so far only I dare venture.

I am not prepared to discuss the equity of the measure that would provide a government subsidy, and in this way keep the home shipbuilders from being driven to the wall; and am quite unable, under the limitations of my present knowledge, to decide whether or not the general good to the commercial interests of our whole country would be increased or decreased by removal of the restrictions attached to foreign-built vessels.

Lewis Johnson, President.

No. 7.—*Moran Bros. Company, Seattle, Wash.*

Replying to your inquiry, I believe it is high time the press of this country stated the facts to the people. The American ship and its foreign trade is too broad and patriotic a question to be used as a football by political parties, as has been done in the past. The people are not informed of the facts; certainly, if they were, there could be no conscientious difference of opinion that some plan must be devised to put the American ship on an equal basis with the foreign vessel, if we are to compete for our share of that trade with the United States, the greatest producing nation in the world and standing sixth in the foreign carrying trade. No further argument should be necessary; and, as I have said before, the wonder to me is that there can be any opposition.

The products of the Pacific coast states are to-day carried from our shores by foreign vessels under heavy subsidies, with the further advantage of the lowest operating expenses by means of the lower wages paid the crews. It is a business impossibility for American capital to compete, and the present condition of our foreign shipping should be conclusive evidence of this.

Robert Moran, President.

No. 8.—*Mexican-American Steamship Company, New Orleans, La.*

I have your letter relative to upbuilding American shipping, which I have read with a great deal of interest. I agree with you that it is a momentous question, which should receive the serious consideration of our government; and in our opinion the only way a successful merchant marine can be built up is for the government to guarantee owners against loss, either for a certain length of time or until lines to different trades could be securely established. This could be done by subsidy, either blanket or to be paid upon examination of the owners' books, as the different trades would require different consideration.

The expense in connection with United States ships is so great that I do not believe that owners would build; nor would the United States companies charter United States ships without encouragement in line with the above. A. L. Roby, Vice-President and Manager.

No. 9.—*United States Standard Register of Shipping, New York, N. Y.*

I duly received your recent favor, but have been unable to give adequate consideration to your inquiry until this time. I am certainly very much interested in the question of building up the merchant marine of the United States, and would be in favor of any feasible measure that may be proposed to that end. I believe that in deciding upon such a measure, the organizations you mention as having the question under investigation should keep in mind that it is not the most desirable that should be urged, but that having the best prospects of adoption. In view of the fate of the bill offered at the last session of Congress, the prospect of the passage of a general subsidy measure does not seem encouraging. My opinion is that, instead of attempting to secure the united support of a particular interest, a measure should be offered having features of direct general advantage that would commend it to all fair-minded men. These features, I believe, should be:

(1) Direct mail communication, under the American flag, with all countries with which we have, or expect to have, important commercial relations, wherever that is commercially desirable. It certainly cannot help our commerce, for instance, to have our mail to South America go "via Southampton" or by tramp steamer.

(2) That all vessels receiving government aid should be so constructed as to be available as auxiliary cruisers, army transports, supply ships, etc., in time of war, and placed by agreement on specified terms at the government's disposition in such contingency.

Under such conditions it may fairly be said that the government payments to such ships would be made for value received. I would suggest, roughly, that payment should be made, on voyages between American and foreign ports, per miles run on steamers of, say, not less than 13 knots speed, the rate of payment to be increased as the speed of vessel is increased, an additional payment to be made to vessels carrying the mails under contract on specified routes.

I believe the agreement made by the British government with the Cunard line will act as a spur upon Congress, if its real meaning is properly insisted upon. That measure is certainly a most arrogant and peremptory order to us not to meddle with the North Atlantic trade in any shape or manner. I do not believe the American people will consent to be so unmercifully snubbed. As you have asked my opinion, I would submit this, but only as a most general suggestion.

Sinclair Stuart, Surveyor.

No. 10.—*Philadelphia.*

Your communication has just been submitted to me. I am glad that Marine Engineering is taking an active interest in the upbuilding of the American merchant marine, for the condition of our country as regards its merchant marine in the foreign trade is deplorable. I must ask you, however, to relieve me from writing or saying anything for publication.

If Congress is to be aroused to action, it must be by the agitation of citizens who are only interested from a public spirit. Everything written or said by those who are engaged in the business is looked upon as inspired by self-interest.

There is no doubt that public attention is more widely attracted to the subject now than ever before.

Clement C. Griscom.

No. 11.—*John S. Emery and Company, Inc., Boston, Mass.*

In reply to your letter asking our opinion as to the action on the part of Congress as to what is most

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necessary to build up the American merchant marine, we would say that we hardly know how to answer you on this subject.

We have been trying, with others, for years to make members of Congress realize that something should be done to save what little American tonnage we had in the foreign trade, but we are free to say that we think the time has passed when anything can be done to save this line of trade. If something had been done fifteen or twenty years ago, this trade would not have been lost entirely; but the conditions have been growing worse and worse, until now we are free to say that we see little hope of building up the American merchant marine in the foreign trade.

In the first place, so little interest has been taken by Congress that foreigners have been constantly increasing their tonnage, and to-day there is a surplus of foreign tonnage, and the consequence is that freights have declined to such a point that, if American shipowners were given ships free of cost, they could not run them in the foreign trade, and pay insurance, and leave any profit for depreciation and interest in competition with foreign ships.

Since the death of Congressman Dingley, of Maine, who was the best friend, except Senator Frye, that American shipowners ever had in Congress, things have been going from bad to worse, and laws have passed Congress in the interest of sailors and sailors' unions, to the detriment of shipowners; so that it costs still more than ever before to victual and man American vessels, in comparison with foreign vessels.

American shipowners are always noted for feeding their crews better than any other nation, but the present scale of provisions for American merchant vessels is far in excess of that in the American or English navy, or any foreign merchant vessel, and the laws for shipping the seamen in American vessels are made very exacting for shipowners and allow the sailors to desert at will in most any port without redress to the shipowners.

With our excellent system of lighthouses and light-vessels, vessels of all nationalities come to our country and have the advantage of them free of charge, while if an American vessel goes into their ports it pays heavily for light dues and other charges.

If a law could be passed with a discriminating duty in favor of merchandise imported in American bottoms, it would be a help to American vessels; but it would be a long time before even this would warrant the building of more vessels under the American flag for the foreign trade, in our opinion.

DANIEL S. EMERY, President.

While our foreign carrying trade has been gradually slipping away, since the time of the repeal of discriminating duties over half a century ago, those interested in shipping have failed to secure any political redress or assistance from Congress, because of many reasons. In the first place, the shipping question has become, most unfortunately, the subject of politics of both the great political parties. Again, the inability of those interested to unite on one proposition has stood in the way of legislation. Those favoring subsidies have been almost as much opposed to discriminating duties as to free ships. Any number of remedies have been proposed, each antagonistic to the other. All this time our foreign tonnage has been dwindling, until now, when there is but a remnant left, a general cry of alarm has gone out, and the entire country is becoming interested. The first steps, consisting of a campaign of education, have met with success; the press throughout the country is taking up the issue, and, with scarcely an exception, all those who have given opinions assert the necessity of some immediate action. Several movements have been undertaken in this direction, notably by the New York Board of Trade and Transportation, and the Home Market Club of Boston. Interest, however, is not alone confined to the seaboard cities; chambers of commerce throughout the country are considering means to resuscitate our shipping.

A brief statement of the present condition of affairs may be of help. The value of our total foreign commerce for 1902 was two and one-third billion dollars; of the tonnage which was engaged in transporting this, only 873,000 tons, or 8.8 per cent., flew the American flag. Our coastwise commerce has in the meantime increased, until now the registered tonnage amounts to nearly five million gross tons. In comparison with these two figures—one of the foreign commerce, unprotected, but with an immense field to draw upon; the other of our coastwise trade, which, through the wise provision of the law, is restricted only to American-built vessels—is, indeed, a most striking comment on the efficacy of the two systems.

To regain a trade after it is once lost is indeed a much more difficult problem than to retain one already secured; and, although we at one time transported over 90 per cent. of our foreign commerce, especially favorable conditions must arise before we can in any way regain our prestige. Last year the foreign tonnage actually decreased six thousand tons, and not a deep-sea ship has been ordered for two years. With shipyards closing along the coast because of lack of work, and the few remaining American vessels being displaced in the carrying trade, it takes no argument to convince one of the alarming conditions that confront us.

Our ships cost more than foreign-built vessels, although for the last few years all material entering into the construction of vessels intended for deep-sea commerce has been admitted free of duty, but the importation of material has not been found to be satisfactory; wages paid for American shipyard labor are much higher than those abroad. Then, again, the operating expenses of vessels flying the American flag are very much more than on foreign vessels. In the first place, we pay the officers and crew higher wages; must give the crew larger quarters, and feed them better food. It would be no advantage for owners of foreign vessels to enroll their ships under American registry, because nothing would be gained and operating expenses would be much higher. Foreign governments consider the maintenance of a first-class merchant marine as necessary to their welfare, and are pursuing a policy of heavily subsidizing their vessels, which may be called upon for important service in time of war. Under these conditions it is absolutely impossible for the American ship to successfully compete.

Besides these generally known disadvantages, the American ship is handicapped from the first because of the surveyors' discriminations. It is a most natural

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thing for foreign registration societies to discriminate in favor of vessels of their own nationality, and it is not to be wondered at that they will give a home-made vessel higher rating. Again, the rating assures the foreign vessel the preference in the matter of insurance, and this may be the deciding element in a vessel's earning capacity in any given trade. While nominally the fleets of Europe are unprotected, yet they are, in fact, more carefully guarded and subsidized than are any of our industries from foreign competition. While there is protection for practically every manufacturer in this country, the American ship is unprotected, although its first cost is more, and by law the owner must pay more for running it. The argument that governmental funds should not be appropriated to increase the trade of any one class of people, is one which has been heard in opposition to practically every form of tariff legislation or reciprocity. The fact remains, however, that practically all the successful industries have been built up through protection.

In letter No. 1, Mr. James J. Hill states: "It is my judgment that no bonus or government aid would create an American merchant marine in opposition to those of foreign countries"; and also: "The United States has built up a system of railway transportation, under which the public is served on an average of one-half the rates charged in Europe for like service, and this is done while wages are very much higher." It should be recalled, in this connection, that the transcontinental railways would not have been built had not the government deeded to them immense tracts of land lying along proposed roads. The resulting benefits to the whole country from the construction of these roads, and thus making possible the development of the enormously fertile plains of the West, are appreciated by all; yet this would not have been possible if the roads had not had government assistance.

In 1848, at the time when our ships were sailing every sea, the English economist, David Ricardo, said in Parliament: "It was a singular circumstance that, although the American vessels were the dearest-built and dearest-manned ships of the world, they had two-thirds of the whole trade between this country (Great Britain) and the United States; while the Russians, which were the cheapest ships in the world, were obliged to give us the whole trade between their country and ours." This was at the time when the policy of discriminating duties, sanctioned by Washington, Jefferson, and Madison, had built up our great fleets.

Other reasons which have affected shipbuilding today are caused by two opposing elements, the labor union and the capitalist. As a result of the strikes along the seaboard, shipyards have been seriously crippled, and at a time when the business did not warrant the advance of wages. A yard which was two years ago in a prosperous condition has actually closed down because of the continuation of strikes, and it is the boast of the labor leaders that they forced the owner into bankruptcy because he would not comply with their demands. How it is possible for men to be so short-sighted as to believe they are helping the cause of labor by ruining the employer, it is impossible to see. On the other hand, the exposures now being made public of the methods of organizing the Shipbuilding Trust show a condition of incompetency, treachery, and intention to defraud the public by men who had been considered capable leaders, such as to sicken the investor and place a ban on shipbuilding in the eyes of many people. These two conditions, however, are not at the root of the trouble, but have followed in the footsteps of the general depression in shipbuilding.

Discriminating duties seem to present less difficulties in the path of legislation, and, in our opinion, are more just than the subsidy system, which is possible of being operated in a partisan method. A reduction of, say, 10 per cent. of the duties on goods imported in American bottoms would provide the necessary stimulus and protection to start up shipbuilding. Under this system our foreign tonnage was rapidly built up, and we quickly assumed a leading position as a maritime nation; a return to this system should produce similar results.

Meeting of the Society of Naval Architects and Marine Engineers.

The eleventh general meeting of the Society of Naval Architects and Marine Engineers will take place in New York, N. Y., at 10 A.M. Thursday, November 19, 1903, at the rooms of the American Society of Mechanical Engineers, 12 West 31st street. The session will continue through Thursday and Friday. On Friday evening, the 20th, at 7 o'clock, the annual banquet will be held. Members intending to propose candidates for membership can secure blank application forms by addressing the secretary. All applications should be returned to the secretary on or before November 17. A list of the papers to be read is as follows:

THURSDAY, NOVEMBER 19, 1903.

1. Progressive Trial of Ferryboat *Bremen*. By Col. Edwin A. Stevens, Vice-President.
2. The Isthmian Canal. By Civil Engineer A. G. Menocal, U. S. N. (retired).
3. Notes on the Arrangement and Construction of Steam Pipes and their Connections. By R. C. Monteagle, member.
4. Gasoline Engines for Marine Propulsion. By D. H. Cox, member.
5. Some Thoughts on the Design of Modern Steam Yachts. By Clinton H. Crane, associate.
6. Water-tight Subdivision of Warships. By Commander Wm. Hovgaard, Royal Danish Navy, member.
7. Non-corrosive Nickel-steel Boiler Tubes. By Albert Ladd Colby, Esq.
8. Curves of Form of the Initial Condition. By George C. Cook, member.

FRIDAY, NOVEMBER 20, 1903.

9. The Metric System in Relation to the Shipbuilding Industry of the United States. By Naval Constructor J. H. Linnard, U. S. N., member.
10. Electricity in Manufacturing Plants. By W. M. McFarland, member of council.
11. Description of the Design and Building of the 21,000-ton Steamships *Minnesota* and *Dakota*. By Charles R. Hanscom, member.
12. Ships' Forms Derived by Formulæ. By Naval Constructor D. W. Taylor, U. S. N., member of council.
13. Some Notes on the Performance of the Torpedo Vessels of the U. S. Navy at Sea. By Lieut. L. H. Chandler, U. S. N., associate.
14. Notes on the Launching of the Cruiser *Chattanooga*. By M. S. Chace, member.
15. Notes on Side Launchings. By Assistant Naval Constructor W. G. Groesbeck, U. S. N., member.
16. Launching of Large Merchant Vessels. By W. A. Fairburn, member.
17. Displacement and Stability Calculations. By Professor W. S. Leland, member.
18. Graphic Calculations of a Ship's Stability. By Prof. M. H. Bauer, member.

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CHARLES W. RAE, RECENTLY APPOINTED ENGINEER-IN-CHIEF OF THE UNITED STATES NAVY.

Mr. Rae, the subject of this sketch, is well known among naval engineers because of his strong personality and fine professional record. Mr. Rae was born at Hartford, Conn., June 30, 1847, and is a son of the late Rev. Luzern Rae. His inclination led him to the study of marine engineering, and he entered the Polytechnic Institute, Troy, N. Y., from which college he graduated with the degree of civil engineer in the class of 1866. He then attended the United States Naval Academy, Annapolis, Md., and was in the class of 1868, which was the first year in which engineers were ever graduated from that institution. He was on sea duty following graduation and served on many of our warships and on all stations except the Asiatic.

At the time of the first consideration of the transisthmian canal Mr. Rae was a member of the Tehuantepec and Nicaragua Canal surveying expedition during the years 1869-71, and had charge of the line of levels in the field and of the resultant work in the office. In his shore duty he was assigned to stations requiring hard work. In 1874-78 he was instructor at the United States Naval Academy, and in 1893-97 he was head of the department of steam engineering in that institution. In the latter year he was appointed member of the board presided over by President Roosevelt, then Assistant Secretary of the Navy, which was commonly called the "Personnel Board," which recommended the amalgamation of the line and engineering corps. Admiral Sampson, at that time captain of the battleship *Iowa,* was also a member of the board. He has also served in the office of Naval Intelligence and in the Bureau of Steam Engineering, Washington. Throughout the war with Spain he was chief engineer of the battleship *Iowa,* which was engaged in the bombardment of San Juan, Porto Rico, and in several bombardments of the defences at the entrance to the harbor of Santiago de Cuba, and finally in the destruction of Cervera's fleet.

In the words of the Navy Department, "for his eminent and conspicuous conduct in battle" Chief Engineer Rae was advanced three numbers in rank and received the medal for the campaign in the West Indies. At the time he was appointed Engineer-in-Chief of the Navy and Chief of the Bureau of Steam Engineering, Mr. Rae was on duty as a member of the board for the examination of officers for promotion, and technical examiner for the United States Civil Service Commission. Rear-Admiral Rae, which title he now bears, enters upon his very arduous work with the respect and cooperation of the entire service.

REAR-ADMIRAL CHARLES W. RAE, ENGINEER-IN-CHIEF, UNITED STATES NAVY.

Erratum.—The article entitled "Internal Lubrication for Marine Machinery," which was published in the October number of MARINE ENGINEERING, was written by Mr. H. C. Dinger, Lieutenant, U. S. N. The name was misspelled.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

THE approaching meeting of the Society of Naval Architects and Marine Engineers should be an occasion of great interest and importance to the shipbuilding interests of the country and to those who are concerned in them. The lines of natural activity for such a society lie within scientific and engineering boundaries, and within such limits its powers for good to the industry at large are great. It serves to bring together representatives of various branches and from various sections of the country, and gives opportunity for personal contact and for a ready interchange of ideas, which is certainly of the highest value to all who may be able to attend. This opportunity for reciprocal contact between men engaged in the same field of work is perhaps of not less importance than the opportunity of hearing the reading and discussion of the papers, especially as the latter will be forthcoming later in printed form. However, it is safe to say that valuable as the opportunities for general contact may be, it is very sure that a successful meeting could scarcely be held without a good list of papers and the attendant discussion to serve as the main feature. In respect to the papers for the coming meeting, the programme, given in another column, promises well, and it is unfair to judge in advance of their actual presentation. It is perhaps not too much to say, taking the papers as a whole which have been presented during the past few years, that, good as they are, they should have been better. This is, moreover, no mere platitude. The papers do not, we are satisfied, represent the best that the members of the society can do. As an exponent to the whole world of the scientific and engineering capacity of American shipbuilders and engineers, the level is too low; and as a contribution to the world literature of the subject and to the advancement of the scientific basis of marine construction, the results are not worthy of the place which we should seek to occupy.

These remarks are not intended as a criticism on those who have presented papers before the society, except to this extent, that while there have been some contributions of the highest excellence and of permanent value, the number has not been as great as might be wished and the average result is on too low a level. This apparently springs primarily from the fact that the mode of life of those in this field of activity is too strenuous on the commercial and administrative side to allow the proper manifestation of the impulse toward scientific investigation. We refuse to believe that the talent engaged in this field is not capable of better things than we have yet seen, or, at least, more of the higher type of scientific engineering work; but the fact seems to be that we are all so occupied primarily in making money for stockholders and in the achievement of immediate results, and hence in the practice of the immediate operative branch of the art, that but small opportunity is left for pushing research into the unknown and adding to the available methods and means for carrying on the industry. We do not assume that anything which can be said in these columns will have any particular effect on the result, for it is a natural consequence of the nature of things as they exist at the present time in the United States. The reason reaches down into our national character and cannot lightly be changed. It will do us no harm, however, to recognize the situation as it is, and it certainly is to be regretted that conditions are not such as would make possible a more liberal exhibition of the natural genius which the society certainly possesses in its membership. In the meantime we

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may hope for at least gradual improvement in conditions and for corresponding improvement in the number of important contributions which the transactions of our society will be able to present as its contributions to the world literature of the subject.

Space lacks for adequate reference to the discussions. Here, however, is likewise room for great improvement, conditioned, we believe, primarily on getting the advance copies of papers into the hands of the members at an earlier date. This is again dependent on the members themselves; for, if those who write will not furnish copy in time for such presentation, the management can scarcely supply the advance copies at the earlier date desired.

A further reason for the importance of the coming meeting is found in the present situation in shipbuilding; and while, as we have noted, the normal activity of the society lies along scientific and engineering lines, it may be questioned whether some part of the deliberations on the present occasion might not be well turned toward an examination of the conditions in the commercial and practical field, and of what steps might or should be taken to place matters on a more normal basis. It is, of course, true that the society has no power to change economic conditions, nor can it undertake, as a society, any active programme involving legislative or congressional action. Such action means, unfortunately, a question of politics, and by natural limitation the society is thus cut off from its proper right of initiative in what should not be primarily a question of politics at all, but rather one of economics, and calling for consideration on broad and patriotic planes. Such questions must, of course, be dealt with cautiously in the meetings of an engineering society; and while, perhaps, but slight initiative could be taken, we believe that it might do no harm if a heart-to-heart experience meeting could be held, participated in by representative builders from the various parts of the field, and that possibly some steps might be devised which would aid in bringing matters into a more satisfactory condition. In any event, the condition is one which merits the most serious attention of all interested; and whether or not any initiative can be taken by the society, the members might individually gain a better understanding of the situation, and be the better able to cope with it, each in his own particular field.

WITH this end in view we present in other columns the opinions of several men, well known in shipbuilding and shipowning, on the general conditions of these industries and remedial methods to be applied. The general opinion is in favor of discriminating duties, such as existed during the early days of the Republic, and which was one of the causes of building up our former glorious marine. So imperative is it that these two industries receive governmental consideration that we urge upon all our readers to give the subject their careful thought and impress upon their congressional representatives, either Republican or Democratic, the absolute necessity of some action being taken up by the coming extra session of Congress.

It is stated, by those who are opposed to any government assistance, that American brains and capital will invest in shipping, provided the returns are satisfactory; also that, as other countries, notably England, do not discriminate against foreign ships, we should follow the same principle. These statements are most misleading. Every foreign country with a merchant marine of large tonnage has paid the utmost attention to this question, and has seen to it that its ships were given every possible assistance, principally in the way of subsidies. The most recent and most conspicuous example of this is in the agreement between the British government and the Cunard line, in which the former has, in fact, become a partner to the company in building and maintaining a fast fleet of ships for the North Atlantic. It is an evidence to what extent the British government is prepared to go to maintain supremacy on the seas. It is against these highly favored lines under government patronage that our vessels must compete. In the first place, our ships cost more, the wages paid to all of the crew are much higher than those for foreign vessels, and the food and accommodations for the crew must be better. In the face of these conditions can it be expected that our ships can enter in the foreign trade? The greater wonder is that there is still a vestige of American ships left. It is estimated that over one hundred million dollars are paid annually to foreign companies for the transportation of passengers, mails, and freights. This amount largely offsets the balance of trade and increased prosperity which our country would otherwise enjoy. We trust that Congress will see the seriousness of the situation and will enact suitable legislation.

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The Skipper's Turbine.

BY E. A. BLACKWELL.

During the early part of the '90s I was connected with a machine shop in one of our Eastern seaboard towns that did considerable marine repair work. We had a good pair of shears, and a good slip and pier in the rear of our shop where tugs and yachts drawing up to 14 feet could lay up while repairs were being effected. We also had a very good lot of tools, and we could handle almost any job that offered, especially repair work. Our work was mostly on tugs and yachts, and, as it was always satisfactory, many of these craft returned with work for us from time to time, and so I made many acquaintances with the captains and engineers.

Among my acquaintances thus formed was a jovial old captain, on whom his seventy years of life sat very lightly, considering that more than fifty of these had been spent upon salt water. The "Skipper," as we always called Captain W——, was a man of large and commanding figure, standing nearly 6 feet 3 inches high. His snow-white hair and the peculiar sailorly cut of his beard made him look a perfect type of the old-time sailor.

During our acquaintance Skipper and I had many a talk. He had many "hobbies" to ride, but the principal one of these was the propulsion of ships, and he was firmly convinced that some day he would discover some means of propelling ships that would revolutionize marine engineering and turn the existing laws of hydrostatics topsy-turvy. I rather liked the old Skipper, and I often helped him in a friendly way, by sketches or otherwise, to ride his "hobbies." Among the Skipper's deficiencies was his lack of education, and especially along the lines of mathematics. One day, while standing down at the end of our pier, I saw the Skipper's tugboat come limping up to the dock under one bell. After greeting the Skipper, I found that his engineer had "melted her down" on the crank pin. The pin was found to be so badly cut that it would require filing to true it up, and, the brasses never having been babbited, I concluded to bore them out and rebabbit them while the pin was being smoothed up.

After we had his job well under way, Skipper called me into his room abaft the pilot house to unfold to me his latest scheme. "Boy," he said, "I have got her now. You know as well as I do that engines of tugboats, as they are now built, are always more or less a nuisance, due to breakdowns. They are always running hot or breaking down just when business is at its best. Now, with my pumps it is different. Take, for instance, my wrecking pump: she is always ready for work. And say, boy, I believe if I ever gave her a suction in this river I could pump the old stream dry in an hour."

I said rather mildly that I hoped he would never execute any such maneuver as that, as it would seriously inconvenience other people that used the river, as any such a move on his part would leave them, as well as himself, aground.

"Well, what I am up to now is this: I am going to take this worthless heap of scrap iron, that you call the engine, out of this boat, and leave only her boiler and her tail shaft and her propeller in. Then I am going to put in a turbine water wheel, connect this on my tail shaft, and then put in a big duplex pump, and pump water into my turbine wheel. Why, boy, I often wonder that I never thought this thing out before, because the whole thing is so simple. Now, then, you get a pencil and paper, and give me a hand to 'figger' this thing out."

I took out a sketch pad and pencil, and reamrked: "You will want as much power in your boat under the new arrangement of machinery as you have now, won't you, Skipper?"

"Yes, yes; that's the idea, boy."

"Now, your present 'conglomeration of scrap iron,' as you call your engine, is a twenty square. This would make the effective area of your piston (less one-half the area of your 3 1-2-inch rod) about 309.35 square inches; then your piston travel in feet per minute would be 20 inches × 2 × 100 revolutions = 4,000 inches ÷ 12 = 333 feet. Then we have 309.35, the effective area of the piston, × 333, the feet traveled per minute, ÷ 33.000 = 3.12 H. P. This would then be the horse-power constant for one pound mean effective pressure on your piston; and since you carry from 115 to 125 pounds boiler pressure, we will assume a mean effective pressure of 75 pounds. Then 3.12 × 75 = 234. This is the horse power of your present engine. Do you understand, Skipper?"

"Well, no, boy, I can't say that I do; but I guess she's all right, though."

"Well, now, as we have a fair estimate of our horse power developed, our next step is to find our steam consumption. As I believe your engine to be in good condition, and the piston and valve tight, we will assume a steam consumption of 30 pounds per indicated horse power per hour; then 30 × 234 = 7,020 pounds of steam consumed per hour for our engine.

"Now we will take our turbine wheel. To the best of my knowledge and belief, a good turbine wheel will only utilize from 60 to 80 per cent. of the theoretical head of the water used. We will split the difference here and say that our turbine utilizes 70 per cent. Then we will have to add 30 per cent. to the horse power of the pumps we are going to use to pump the water into our turbine. Adding 30 per cent. to our engine power would be 234 × 1.30 = 304.20. This is the horse power, then, of our pumps. A pump of this size, duplex and not compounded, would use at least 100 pounds of steam per horse power per hour. Then 304.20 × 100 = 30.420 pounds of steam consumed per hour for our pumps."

"Yes, yes, boy, I catch on; and say, you're a 'side wheeler' on 'figgers,' all right."

"Now hold on, Skipper," said I; "let us go a little further on this subject. We have now found the steam required to run the engine and the pump. Now let us look at the economy: 30.420 pounds per hour, the steam consumed by the pump, divided by 7,020 pounds, the consumption of the engine, is 4.3. This, you will plainly see, is an increase of 4.3 times your present steam consumption.

"In other words, Skipper, you will want about four more boilers the size of your present one, and I am afraid that to handle the water you would require would make the size of the pump so large that you would have to tow a pontoon alongside with the pump erected on it. This would make a rather ungainly rig, Skipper, don't you think so? Now, is there anything else I can help you with in regard to this scheme? And, while I think

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of it, there is another small item I have forgotten to mention, and that is this: You will remember there is no method of reversing the motion, or direction of rotation, in a turbine water wheel, and, as you sometimes need to back, this would require *one more turbine,* with the buckets set opposite to our go-ahead wheel. This would, of course, mean a few large valves, or gates of some description, so as to change the flow of water from our go-ahead to our backing wheel."

"No! No! That will do, boy," remarked Skipper. "And say, boy, don't you say another word about turbines, but bear a hand with them brasses, as I want to get under way as soon as they are ready."

A Broken Crank Shaft on the Syracusa.

Much concern was felt over the German steamship *Syracusa*, which sailed from Victoria, Brazil, on September 5, laden with coffee, and arrived in New York ten days overdue. The delay was the result of a most unusual break to her shafting, which was replaced after the hardest kind of work.

Seven days out from port, when in a heavy sea, the crank shaft of the low-pressure cylinder broke close in the after coupling, and gave out a shower of sparks like an electric fire. The engineer in charge, who was standing near the throttle, at once closed down the engine; the propeller continued revolving for a few turns, but the engine stuck fast. The crank shaft is of solid forging, built in three interchangeable sections. It was at once evident that the repair would entail the hardest kind of work for the entire crew. The engineer's force consisted of chief and three assistants, three oilers, six firemen, and the coal trimmers. A spare shaft was stored in a recess at the forward end of the engine room, and it required special tackle to unship the old one and get the new one in place. It was found, however, that the bolt holes in the couplings of the new shaft did not correspond exactly to those of the adjoining couplings, and therefore it was necessary to ream out all the holes. There were nine in each coupling, 2 3-4 inches diameter. A special reamer had to be built, as no tools were at hand large enough to perform this heavy work. The holes were tapered, and tapered bolts fitted in. The break was a most unusual one. The shaft had been literally twisted off the coupling and the broken end was spherical, the break showing that there had been a fracture for some time, and that the last material to give way had been literally pulled apart and spun round like candy. The wrenching had pushed the thrust block loose from its foundations and bent the floor angles. Before the shaft could be lined up these angles had to be straightened, and both a fore and aft stiffener bar, between thrust and engine foundation, and a cross stiffener on top of the floor, were bolted on.

This work was done while the vessel was rolling, for the most part in heavy seas. The captain and all the deck force lent a hand below, and the work was carried on day and night. Two whole days were spent in making the necessary tools for boring, and then three days were required to bore the holes, the men working in three-hour shifts. After the spare shaft was in place, another day was required in lining up and repairing the thrust shaft and bearing. The work was all accomplished under the most difficult conditions, and Chief Engineer Sieh and his assistants deserve the highest credit for their ingenuity and perseverance.

The *Syracusa* is a schooner-rigged ship, built by the Society John Cockerill, Hoboken, Belgium, 1894. She is 1,543 net tons, 320 feet long between perpendiculars, 40 feet beam, and 27.4 feet deep. The engines are a most remarkable set of triple-expansion, three-cylinder engines, and were on exhibition at Antwerp before being placed in the steamer. The cylinders are 27, 44, and 70 inches diameter by 44 inches stroke, and the shaft is 13 inches. Almost all the parts are finished, and it is in truth a show design. Each cylinder and its steam chest is a separate casting, and they are held together at the top by horizontal wrought-iron braces. The cylinders are mounted at the back on cast-iron columns forming part of a cylindrical horizontal condenser, and at the front by wrought-iron columns. All forgings and castings appear to be of the best quality. Such care has been shown in turning out this engine that it is all the more remarkable that such a gross mistake should be made in not having the bolt holes of the spare shaft to match. This is but another case showing the absolute necessity of equipping a marine engine with the most accurately fitted spare parts. When necessary to make repairs at sea, it is invariably the case that they must be carried out under the most exacting conditions, and to subject the engineer and his force to such severe work, and at the same time endanger the total loss of the vessel and the crew, all because of carelessness in fitting a spare part, is indeed unpardonable. J. W. H.

PERSONALS.

T. H. M. Brown, formerly general shop foreman with George Fenwick and Company, Ltd., Hong Kong, China, has now taken the position as engine draftsman with the Neafie and Levy Ship and Engine Building Company.

William Alfred Perry, who has been president of Henry R. Worthington, Incorporated, has retired from business.

John M. Dunbar, who was formerly employed in the drafting offices of the New York Shipbuilding Company and the Townsend-Downey Company, is now working his way westward. He has temporarily given up his profession, and, with a friend, is working on farms en route West.

Frederick Jenkins, formerly machinist at Nixon's Shipyard, is now machinist at the Wheeler Condenser Company.

G. M. Aitken has accepted a position in the hull drafting room of the Union Iron Works. Mr. Aitken was formerly with the Lidgerwood Manufacturing Company.

Arthur W. Goodrich, formerly ship draftsman at the Union Iron Works, has now taken the same position in the Department of Construction and Repair, Mare Island Navy Yard, Vallejo, Cal.

William H. Crawford, Jr., of San Francisco, Cal., is now associated with Charles C. Moore and Company, engineers and contractors in the same city.

Dr. Hans Goldschmidt, inventor of Thermit welding process, is coming to this country to lecture on this process early in November.

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Walter S. Bickley, who for some time has been assistant superintendent of the Pennsylvania Steel Casting and Machine Company, Chester, Pa., has been made manager of the company.

C. B. Loomis, formerly with the Rock Hill Furnace, Pennsylvania, has accepted a position as mechanical draftsman of the Union Iron Works.

James McLaughlin has resigned from the Barr Pumping Engine Company, Philadelphia, Pa., where he held the office of secretary and treasurer.

Frank H. Cross, for several years connected with the Columbian Iron Works, Baltimore, Md., and the Wm. R. Trigg Company, and lately of the Siegel-Cooper Company, marine contract department, has accepted a position with the Carley Life Float Company as manager of the New York office, F 4 and 5, Produce Exchange.

Charles H. Cramp Resigns.—At a meeting of the board of directors of William Cramp and Sons' Ship and Engine Building Company, held on October 2, Charles H. Cramp tendered his resignation as president and was chosen chairman of the board—a new office. The following officers were elected: president, Henry S. Grove; vice-president, Edwin S. Cramp; general manager, R. W. Davenport; the latter was also chosen a director of the company.

The Rapid Run of the Kearsarge.

Editor Marine Engineering:

I have been interested in the account in your September issue of the remarkable run of the *Kearsarge* across the Atlantic, particularly as it affords you an opportunity for comparing the runs of the *Columbia* over the same course some years ago, that of the *Good Hope* to Cape Town in the present year, and this run of the *Kearsarge*. May I be permitted to point out one fact which seems to bear a very important part in rendering the comparison much more favorable to the American ships than to their English cousin? In running across the Atlantic the two American boats would be able to secure for their circulating pumps, for every knot of run, water which would never have a temperature of more than 65 degrees, probably. On the other hand, the *Good Hope* would be obliged to put up with water that would average anywhere from 10 to 20 degrees warmer than this in the North Atlantic for a very large portion of her run.

I see that Kent in his handbook says, with reference to this question of condensation in the tropics: "For ships whose station is in the tropics the allowance (area of cooling surface) should be increased by 20 per cent." That is to say, then, that the *Good Hope* on her run to Cape Town was handicapped for at least two-thirds of her run by having 83 per cent. only of the condensing surface which she should have had in order to put her on an equal footing in competition with the other two.

In order to see what a handicap this means, it may be remembered that at the opening of the South African war the White Star steamship *Majestic* was chartered by the British government to transport troops with all possible speed to the Cape. On her regular route—namely, almost the very one followed by the *Columbia* and *Kearsarge*—the *Majestic* can run from port to port at very nearly 20 knots an hour; but, although pushed to her utmost capacity on her run to the Cape, so telling was that 13 per cent. discount that she barely averaged two-thirds of her North Atlantic passage time.

P. B.

We agree with the estimate of our correspondent for cooling surface on account of warm circulating water, but he has overlooked the fact that all three ships were run at reduced power, while they are fitted with condensers capable of handling the exhaust from the engine when running at full power, which on the *Good Hope* was about three times the power developed on her recent run to South Africa. We doubt not that the entire condensing surface was used on the main engines, for there is no way of cutting part of it out, even if desired. With this superabundant surface a good vacuum surely could be obtained.—Editor.

ENGINEERING SPECIALTIES.

A Star Indicator for Navigation.

Navigation has of recent years become a more exact science and the rough approximation of a ship's position at sea is no longer satisfactory, for the increased size and cost of vessels, and the many hundreds of souls on a single steamer, make it necessary that every precaution be taken to have the exact location of the ship known to the navigator at every hour of the passage.

While the improvement, in recent years, of star telescopes and binoculars has undoubtedly led to a greater use of star sights, their general use has been restricted in practical navigation, for an observer does not care to go through a lengthy longitude calculation unless he is certain of the identity of his star.

Navigators recognize the advantages of star sights for longitude in high latitudes in winter, but the question of identifying the star is a serious hindrance. Frequently after an overcast day the eastern horizon clears sufficiently for the observer to see one star, but it is impossible for him to identify it when seen alone, and thus many longitude sights are lost.

Again, as navigators are generally only familiar with stars that are named in the nautical almanac, they do not make use of many other visible stars which have no proper names assigned them. Thus there are 19 stars visible in the North Atlantic all equal to or exceeding the magnitude of Polaris, and there are 29 stars of the second magnitude of equal or greater brightness than Markab. Besides these there are 25 other stars of the second magnitude which may be used for taking observations with a daylight-illuminated horizon.

A star indicator has been recently devised and copyrighted by Dr. H. G. Geissinger, of the International Mercantile Marine Company, by which star observations may be quickly taken and with absolute certainty. The indicator, as shown in the accompanying cut, consists of a northern-star chart, 16 inches in diameter, printed upon ivory celluloid, upon which are stars of the first, second, and third magnitudes, the latter being distinct from the useful stars. The star letters are very clear and follow the style of the nautical almanac. The chart is laid out as if one were looking down upon the heavens, so that east and west bear their natural relations. There revolves about the north pole of the

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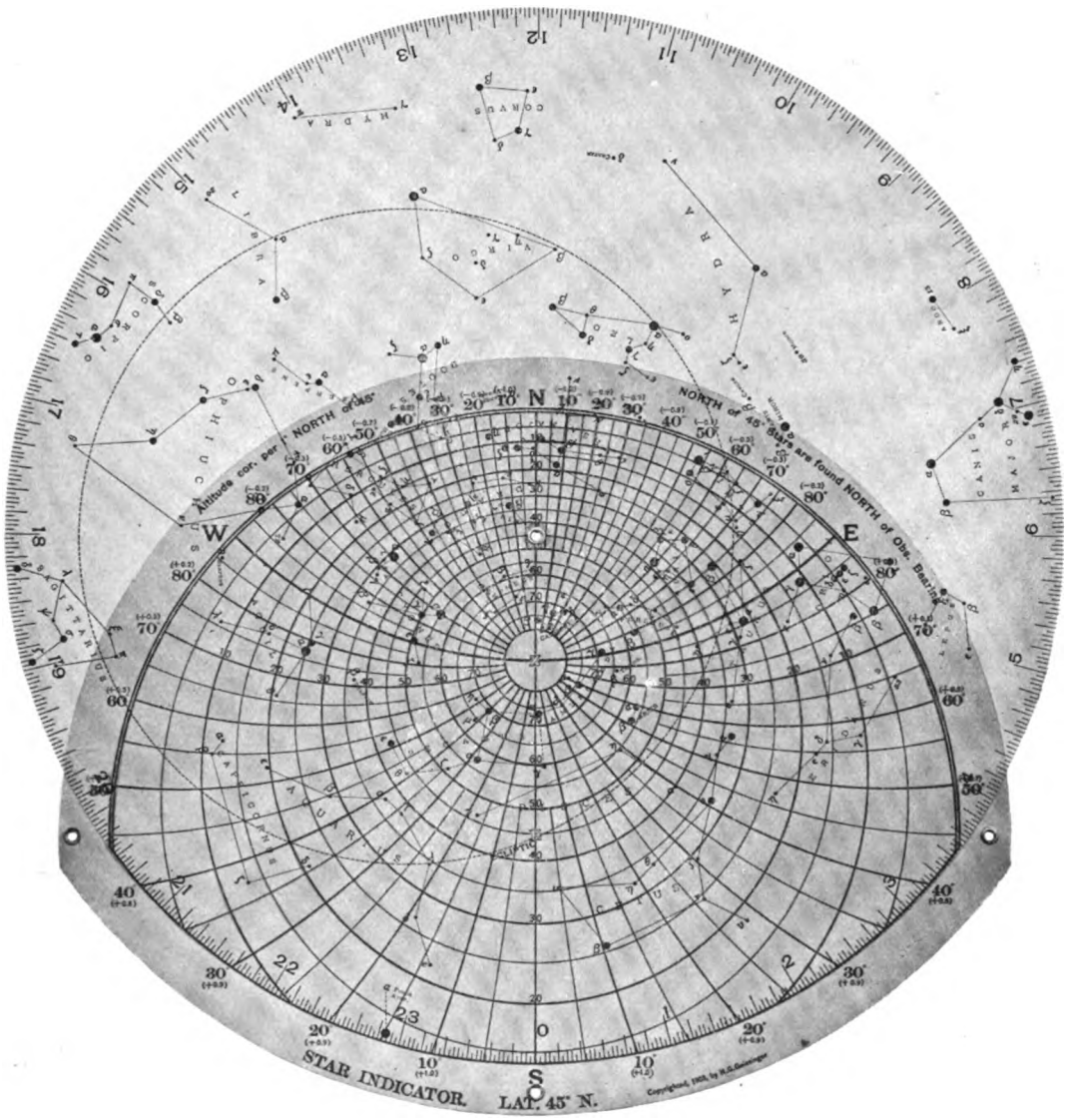
chart a transparent celluloid scale, having circles of altitude from the horizon to the zenith, and lines of azimuth radiating from the zenith. When the meridian of this scale is set to the right ascension of the observer's meridian, all the stars within the horizon are seen to occupy their positions of altitude and bearing.

To find the observed star on the chart, it is only necessary to calculate the right ascension of the meridian at the time of observation (as for the correction of a pole-star sight), set the indicator to that time, and follow the observed altitude and bearing to their intersection. Having found the star taken upon the chart, the observer has only to revolve the meridian of the indicator over its center to find the star's approximate right ascension. This enables him to locate the star in the nautical almanac. He can further read off the star's declination, and as the chart gives the magnitude of the star, its letter, and its constellation, there cannot be any mistake in selecting the proper data from the almanac. Any prejudice against the use of minor stars without proper names is quite unfounded; if a star is bright enough to be picked up by the sextant, its contact with the horizon can be made more perfect than that of a brilliant star.

The identification of a star depends upon the time and altitude, and to a minor extent upon the azimuth, for it will be found that, with very few exceptions, there are no stars of first and second magnitude occupying the same altitude within 15 degrees of each other in bearing. This is therefore the only method of identifying stars wherein the bearing may be approximate. It has been found that a rough bearing, within half a point, identifies the star in almost all cases, and uncertainty for want of the exact bearing is apparent at sight.

A still more important use of the indicator is that it may be set in advance for a twilight observation and thus give the altitude and azimuth of any suitable star for any given time. With this data the observer may pick up in early twilight stars which were invisible or passed over by the eye.



A NEW STAR INDICATOR FOR NAVIGATION.

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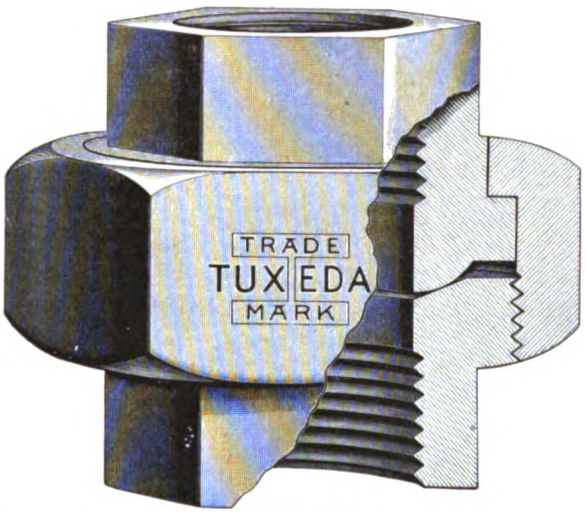
The use of the star indicator thus gives the navigator the same opportunities in the use of stars for longitude as he has had in latitude, at the expense of a small and familiar calculation and a bearing taken without instruments. It inevitably opens up a more extended field of observation.

This indicator, which was thoroughly tested over a period of three years upon several ships of the Red Star line, has been pronounced a ship-shape, practical aid to navigation. It is also of great value for use in instruction in nautical schools, as stars are presented in their intelligible functions of altitude and bearings. As both chart and scale are made entirely of celluloid, they are proof against moisture and handling for an indefinite period. It is especially suited to the transatlantic routes and is available for observations taken between 35 and 55 degrees north latitude.

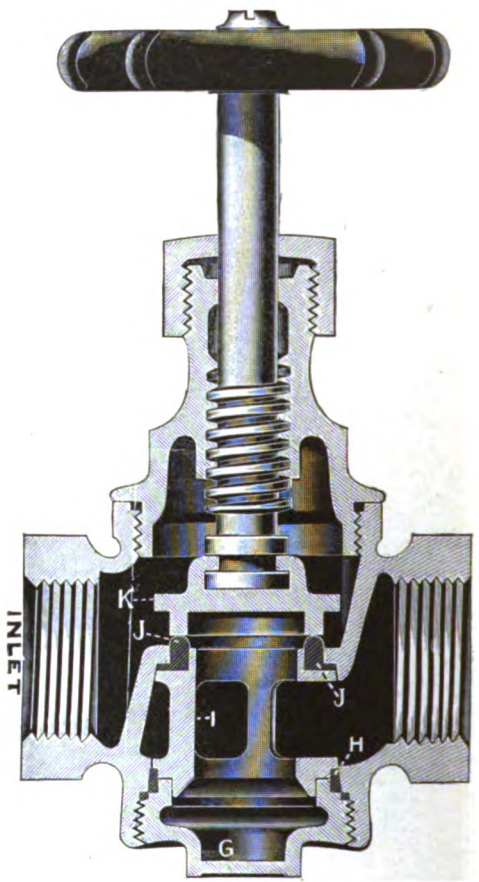


A BRONZE PIPE UNION.

A New Union.

Designing a union that will withstand severe usage, now so common in marine practice, is no simple matter. Heretofore ordinary brass round-end unions have caused so much annoyance and expense that shipbuilders and others have been forced to adopt the use of flanges. The Tuxeda bronze union, illustrated herewith, has recently been placed on the market to supersede flanges, even on brass pipe up to No. 4-inch size. While the union is made very heavy, of bronze, there is not an ounce of metal wasted. It is made with both ends hexagonal for the use of a monkey wrench. The metal at these ends is so abundant that they can be forced on to extra strong pipe without fear of spreading. Polished, they make a fine connection, the appearance or efficiency of which is not destroyed by the use of a Stillson wrench. The nut is heavy and the threads are long and accurately cut. The joint is formed almost on a straight line by a slightly tapered seat and a short-radius nose, which prevents this part from crushing down to the shoulder and insures a joint that expansion and contraction will not affect. It also enables one to bring the ends of the pipe closer in connecting, and this feature, coupled with its excessive strength, will permit of forcing a pipe into line without injury to the coupling.

Unions are easier to manipulate than a flange, and are superior to any iron pattern. When an iron flange does crack, due to a blow or from careless pulling up, there is danger to life and property. When a ship goes to sea no joint is too strong, and it is safer and more economical in the end to use pipe joints that require no packing. The Tuxeda union is owned and manufactured by Franklin Williams, 39 Cortlandt street, New York, N. Y.



SECTION OF BASHLIN RENEWABLE VALVE.

A Renewable Valve.

Among the requirements for a first-class valve are that it shall be made of good material and the workmanship must be of the best. It must be plenty strong enough to not only withstand the steam pressure but the severe strains due to expansion of the pipe and the water hammer, etc. Above all, it must remain tight, and the parts must be interchangeable and the seats renewable.

The Bashlin valve fulfills these conditions, for it is made of the best material and by skilled workmen. All valves are carefully inspected and tested before leaving the works. By referring to the illustration, the construction of the valve will be seen. The spindle has at its lower end a gun-metal disk, *K*, which closes upon the seat ring, *J*. Guides for centering the disk prevent

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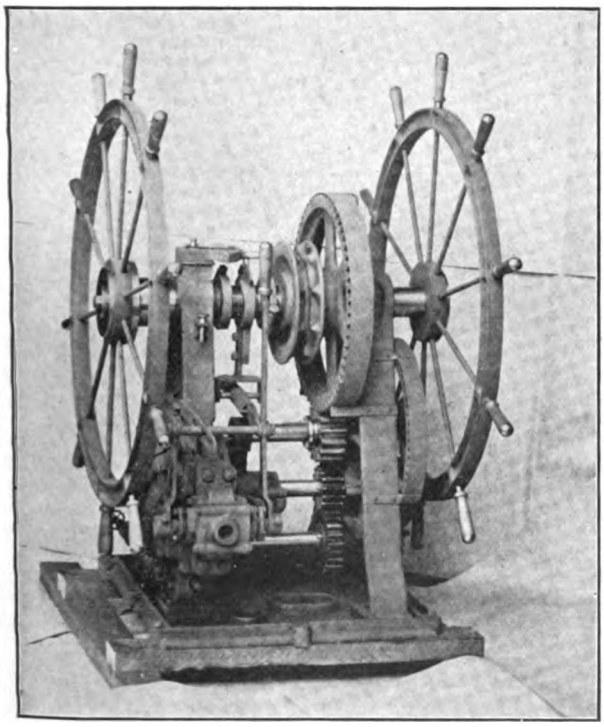
rattling, increase the strength, and insure that the disk will properly close on its seat. The ring *J* rests on a post, *I*, which is inserted through the bottom and held in place by the plug *G*. All parts are made to standard gauge, and thus any part may be renewed. This is a specially desirable feature with the ring seat, which is bound to be cut and worn by the steam. When the seat is cast solid to the diaphragm, if it becomes leaky, a new valve is required. The special point of interest in this valve is that if the seat ring wears out it can be easily removed and replaced with a new one, and that while the valve is under pressure. This is made possible from the fact that there are two seats, one on top of the diaphragm and the other on the flange disk. The plug *G* is slowly unscrewed and the seat *K* screwed down at the same speed until *K* rests on the auxiliary seat of the diaphragm; then *G* and *I* may be removed and a new seat ring put in place. Another feature of this valve is that its stuffing nut also may be packed under pressure. These valves have either flanged or screwed connections, and are made by the Bashlin Company, 177 Broadway, New York, N. Y.



STEAM-STEERING ENGINE.

Compact Steam-Steering Engine.

The cut above illustrates the Dake steam steerer ready to place in a pilot house and connect to steam pipe and steering chains. It is driven by a Dake reversing engine which is backed geared to the chain-wheel shaft by double gearing, fibroid gears being used on the engine shaft, making practically a noiseless machine. The engine valve is connected to steering wheel by a lever, and the gear is stopped, started, or reversed by moving the steering wheel slightly from center to center either port or starboard.

The motor used is of the double-reciprocating, square-piston type, well adapted for direct-connected work where small, compact, and high-speed motors are desired. The working parts consist of two movable pieces, one sliding inside the other, and guided in their movement by a crank on the end of the driven shaft. The inner piston has cored through its body four ports, leading to the four sides or ends of the piston, which communicate with the two ports cut in the cover or cylinder head of the motor. The steam passes through the center and exhausts through the circular aperture; or, when the throttle is reversed, the steam is taken through the circular ring and exhausted through the center port. The engine can be reversed instantly by the valve lever on the motor. All movable parts are cushioned at their reversal, so that the engine can be run at high speed. The wearing surfaces are made ample for maximum loads, and the parts subject to steam heat are made of the best quality of steel and phosphor bronze.

The gear is equipped with an automatic stop, which is adjusted so as to close the engine valve on the engine when the quadrant or tiller has reached its furthest point of travel or hard-over point. Arrangements are made to change the gear from steam to hand power: first, by throwing out the intermediate pinion, which is held in position by lock nut shown in the cut; and, second, by releasing the valve lever and placing a pin through the hub of the steering wheel.

An indicator dial is furnished with machine, and the engine is equipped with automatic oil pump which gives perfect lubrication to the same. Sufficient length of the best quality of block chain is furnished, together with four guiding shelves, to connect the steering gear to tiller chains or cable.

The builders claim for this machine a very simple, compact, and durable gear, occupying a small floor space, thus enabling it to be placed in small pilot houses; also a first low initial cost, the cost of same being low for this class of marine equipment. The Dake steering gear is built in two sizes or dimensions, of 5 and 8 horse-power respectively, and further particulars may be had by addressing the Holland Company, 77 Jackson Boulevard, Chicago, Ill.

Searchlight with Spreading and Converging Lenses.

The searchlight here illustrated is fitted with a new and improved device for spreading or converging the light at will by means of dispersion lenses. Many attempts have been made before to do this, but none of them have ever attained this end in a satisfactory manner. The most common way has been to mount the dispersion lenses in a separate ring which fitted over the front of the searchlight cylinder; to put this in place, however, necessitated the removal of the door containing the plane-glass strips, and then the dispersion lenses, mounted in their own separate ring, were substituted. This was an awkward operation at best, and became a veritable nuisance on a dark and stormy night. The dispersion lenses are much more expensive than the plane-glass strips, and, when in hands not accustomed to the work, were frequently broken.

To obviate this trouble and inconvenience, the lenses

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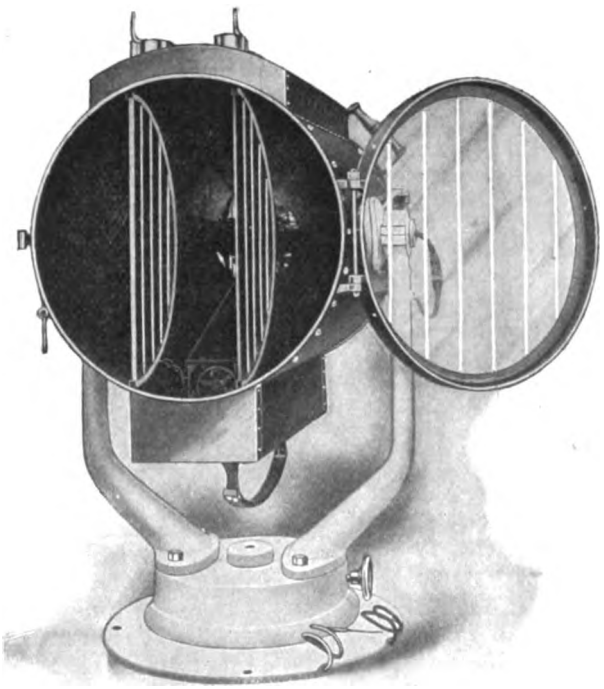
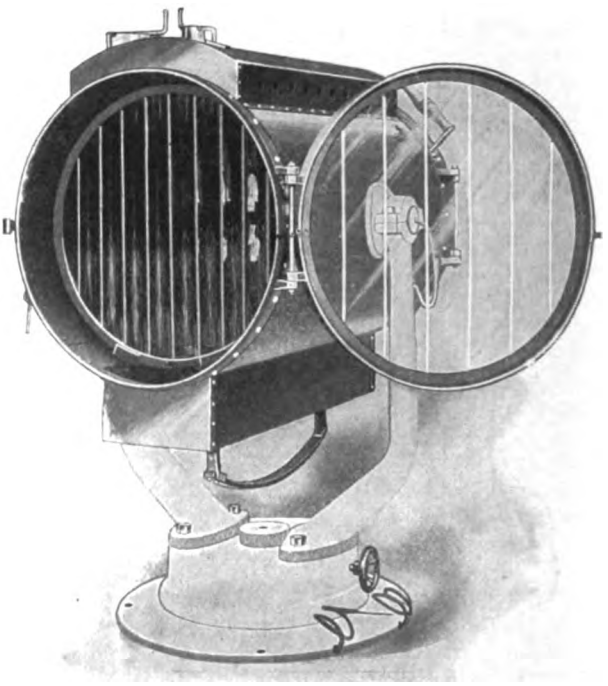
in this new design are mounted in two light brass semicircles, as shown in the first cut. These semicircles are pivoted so that they may be rotated through 90 degrees, or a quarter-circle, by two small handles on the top of the searchlight cylinder. When placed in the first position the lenses present a surface only 1-2 inch thick to the rays of light coming from the searchlight, which surface is so small that it detracts nothing from the brilliancy of the light, which emerges in a solid, straight beam. By turning the handles through an arc of a circle 90 degrees the lenses are swung around, as shown in the second cut, when all the light has now to pass through the lenses and it is spread out according to the curvature of the lenses. It requires but a moment to accomplish this result, and renders the use of the dispersion lenses so very easy that it is expected a much more extended use of them will be made in the future, now that the awkwardness of applying them, the greatest objection to them in the past, has been done away with.





CONVERGING LENSES FREE. CONVERGING LENSES CLOSED.

A SEARCHLIGHT WITH SPREADING AND CONVERGING LENSES.

These dispersion lenses are permanently mounted in the searchlight cylinder, and trimming, cleaning, etc., are readily accomplished without removing them. The door containing the plane glass is left in position and not removed at all.

In the illustration the glass door has been purposely swung back to show the interior of the searchlight. Full particulars will be furnished by the Carlisle and Finch Company, Cincinnati, O., the makers of this searchlight.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 87 vessels of 13,579 gross tons built in the United States and officially numbered during the month of September, 1903.

QUERIES AND ANSWERS.

Q. 172.—What should be the size of a pump to deliver 8,400 gallons of water per hour, working 50 revolutions per minute? Can this problem be worked without assuming the diameter of the cylinder? C. P.

A.—The capacity of the pump depends upon the number of strokes and the displacement of the cylinder, *i.e.*, the area and the stroke. Therefore, for a given pump, these three quantities, stroke in inches, number of strokes per minute, and diameter of cylinder, must be given. In this case, as you state there are 50 revolutions per minute, we judge that the pump has a flywheel and has but one cylinder, so is not the usual form of duplex pump.

Now, solving your problem: 8,400 gallons per hour are equal to 140 gallons per minute, and at 50 revolutions, or 100 strokes, assuming the pump to be double-acting, at each stroke of the pump 1.4 gallons of water will be displaced. The United States gallon contains 231 cubic inches, therefore 1.4 gallons are equivalent to 323 cubic inches. Now let us find the properly proportioned cylinder which has this cubic capacity. It will be borne in mind that a cube contains three dimensions. The area corresponding to the diameter of 6 inches equals 28.27; dividing 323 by this figure we have roughly 11 1-2 inches. At this stroke no allowance is made for leakage or the space which the pump rod takes up on the crank end; therefore it would be well to make this stroke 12 inches at least. Now, assuming a pump with a 7-inch cylinder, the area is 38.48 and 323 divided by this gives us a stroke of about 8 3-8 inches, say 8 1-2 inches. Either one of these cylinders would fulfill the conditions of your problem.

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Q. 173.—Will you kindly answer the following questions through the columns of MARINE ENGINEERING? How do you calculate the theoretical power of a steam turbine? For an impact wheel, such as the De Laval, could you use the following formula, taken from Church's "Mechanics of Engineering," page 808, with proper coefficient for losses?

$$L = \frac{G}{g}(1 - \cos\alpha)(c - v)\,v.$$

where G is weight of steam pressure per minute; c and v the velocities of steam and vanes per minute, respectively; α the angle of the exhaust steam with the initial stream of steam.

Can a formula for the power of a combination impact and reaction wheel such as Parsons turbine be reduced to anything like a rational formula?

Another question I wish to have cleared up is, wherein do the Curtis patents differ from those of Parsons and De Laval? The Curtis turbine seems to be a precise combination of the other two, with the exception of a difference of speed regulation from one and reduced speed by gearing from the other. If the Curtis turbine can be manufactured it seems as though steam-turbine patents are valueless. J. D. C. S.

A.—The theoretical power of a steam turbine cannot be readily derived by any purely rational formula such as that referred to. The chief trouble is with the fact that in the formula neither the amount of steam nor its velocity can be known from a mere statement of the dimensions and conditions of operation. It follows that neither of these factors in the equation can be ascertained without something in the nature of experimental research. Presumably the most hopeful plan for the development of an empirical formula for steam turbines would be the employment of the amount of steam and its change in thermodynamic condition in passing through the turbine, as indicated by the initial and final pressures. By experiment constants could be developed which would serve to indicate closely the quantity of steam which would, under given turbine conditions and under a given pressure, flow through a nozzle of given size; and likewise factors which would indicate the amount of heat transformed into work, as determined by the initial and final conditions of the steam. While the few turbine makers doubtless have such formulas, derived from their own experiments and suited to their own type of machine, the general engineering public has not at command a sufficient range of facts to make possible the satisfactory development of any such set of formulas, applicable to the various types of turbines now on the market. The size of turbines for given power has been thus far arrived at by each maker simply in this empirical manner and guided by his own experience.

We can scarcely, in these columns, attempt any detailed discussion of the character of patent claims. It may be noted, however, that the Curtis and Parsons turbines differ primarily from the De Laval. In the latter the steam is allowed to escape freely as a jet, and the pressure energy is thus transformed, as far as possible, into the velocity energy of a moving jet; and the energy in this form is then abstracted, as far as possible, by allowing the jet to act on a set of rotating vanes. In the Curtis and Parsons turbines this operation is broken up into a series of stages, and to some extent the development of velocity in the jet by expansion, and the abstraction of such energy by action on curved vanes, may be going on simultaneously.

Regarding further the question of patents, it may be remarked that there is and can be no patent on the fundamental turbine idea. Patents in relation to turbines can only hold on combinations of specific devices or forms for the accomplishment of the desired end. Any one can doubtless manufacture a turbine, provided he avoids the particular combinations of devices and arrangements covered by existing patents.

Q. 174.—Will you please answer the following in your Queries and Answers column?

(a) Will boring a hole of any diameter through a solid cylinder or shaft of any diameter increase its strength?

(b) If it decreases its strength, why is it that hollow shafts are so extensively used in our navy, etc.?

(c) Please show method and reason for obtaining the essential thickness of metal, as compared to exterior diameter.

M. F. F.

A.—*(a)* Boring an axial hole through a solid cylinder or shaft will not, of course, directly increase the strength of the shaft. On the contrary, it will decrease the strength to an extent depending on the relation between the diameter of the hole and that of the shaft.

(b) The reasons why shafts are made hollow are briefly as follows:

(1) Defects in a forged shaft are more liable to occur near the center than near the outer surface. Such defects in particular are fine cracks and a lack of homogeneity and balance of molecular condition. Now, under conditions of actual service, such cracks may extend themselves gradually from the center toward the outer surface, and into metal which at the start is free from defects of any kind. This may in time lead to the rupture of a shaft which might at first have a sufficient margin of strength. The removal of the inner core of material, with such cracks and imperfections, will remove the source of such trouble, and will leave clear, perfect, and homogeneous metal, which will remain unchanged in internal structure and condition under all normal conditions of service. Again, should there be any serious flaw in the metal of the shaft, but not quite reaching to the outer surface, the removal of the inner core will serve to indicate the presence of such a flaw, and may thus save a serious breakdown at a later time. The hole, in fact, makes possible the inspection of the metal of the shaft on two surfaces, on the outside and on the inside, and at a distance equal simply to the thickness of the metal shell left remaining. If both of these surfaces indicate the absence of all defects, it may be accepted as good evidence that the metal throughout is true to the indications and that the shaft may be depended upon. The hole, therefore, makes possible a more perfect and complete inspection of the metal, and gives a greater insurance as to the safety and general reliability of the shaft thus inspected. Again, the fraction of strength thus removed is but slight for any ordinary ratio of diameter of hole to diameter of shaft, so that no serious objection can be urged so far as the consideration of loss of strength is concerned. The loss of strength given by the inner core is readily compensated for by a small addition to the outer diameter, as referred to below.

(2) The hollow shaft, for the same strength, is lighter than the solid shaft. This is a further reason for making such members hollow, or, at least, is a further advantage which we are able to reap from such mode of treatment.

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(c) The common proportion of diameter of hole to diameter of shaft is close to one-half. With this proportion the diameter of a hollow shaft needs to be only about 2 per cent. in excess of a solid shaft in order to have equal strength. More generally, the relation between the diameter of the hole, the outer diameter of the shaft, and the diameter of a solid shaft of equivalent strength is shown by the following equation:

$$S^3 = \frac{D^4 - d^4}{D}$$

where S = diameter of solid shaft, D = outer diameter of hollow shaft, d = diameter of hole.

The detailed development of this formula would not be appropriate in these columns, and it will be sufficient to note that the formula rests simply on the equality of the two moments of a solid and hollow shaft against a twisting stress. The following table shows with sufficient closeness for all practical purposes the increase of the outer diameter, in comparison with the solid shaft, in order to compensate for the removal of the metal in the hole:

Diameter of hole in proportion to diameter of shaft.	Increase in diameter of shaft in proportion to diameter of equivalent solid shaft.
.4	1 per cent.
.5	2 " "
.6	5 " "
.7	10 " "

THE DESIGN OF MARINE MACHINERY.

BY W. F. DURAND.

[9] Oval Valve Diagram.

It will be noted that in the Bilgram and Zeuner diagrams the construction consists entirely of straight lines and circles. There are still other forms of straight line and circle diagrams by means of which the movement of a valve may be represented, but the two above described will suffice for diagrams of this class. It may be noted that all such diagrams involving straight lines and circles stand on the same level as regards accuracy, and the choice between them depends simply on questions of convenience or adaptability to the special problem in hand.

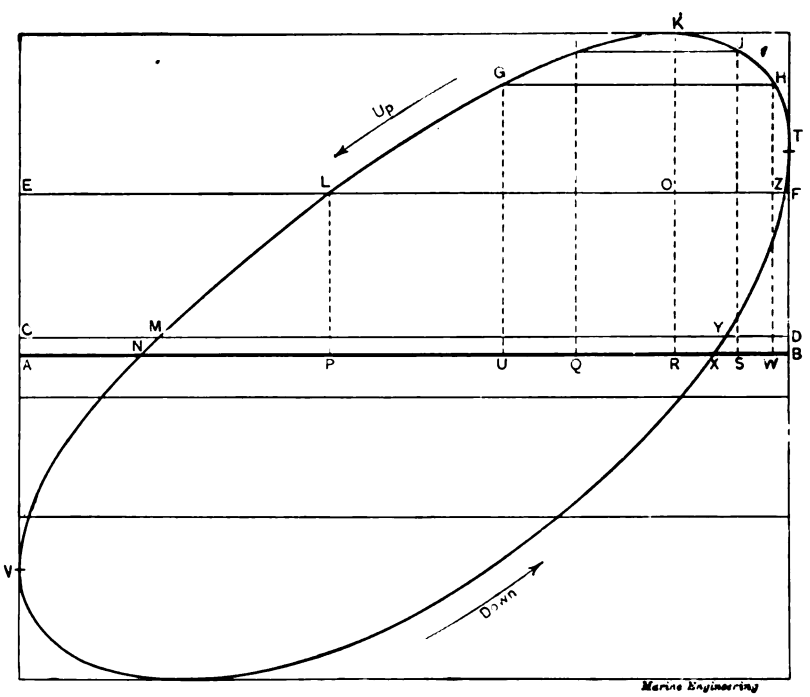

FIG. 14.—OVAL VALVE DIAGRAM.

It will be also noted that in all such diagrams the construction shows the relation between the movement of the crank and that of the valve. The movement of the piston is not directly represented, and, if the angularity of the connecting rod is to be included, can only be found by an additional construction.

For the purpose of representing the actual movement of the valve relative to the piston and including the influence of the connecting rod on the latter, a somewhat different form of diagram may be advantageously employed. Suppose we have a series of relative positions of valve and piston for an entire revolution of the crank or double stroke of the piston. Then we may represent these as shown in the diagram Fig. 14. Let AB represent to any convenient

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scale the path of the piston. Then from the various points along *AB* corresponding to the positions of the piston let the distance of the valve above or below its mid-position be laid off and the points thus determined be joined by a continuous line. It is readily shown mathematically that if there were no effect due to the angularity of the connecting rod or valve rod, the resulting curve would be an ellipse. With these various effects included, however, the result is a somewhat distorted ellipse or oval, as shown in the diagram.

One side of the oval will be found to be more rounded than the other, and this will always be found on the down or in-stroke side. This difference in the curvature of the two sides may be readily traced in chief part to the effect of the connecting rod. Turning to the movement in detail, it appears that at the lower end of the stroke or piston at *B* the valve will be at a distance *BT* above its mid-position. When the piston has gone to *S* the valve will be at a distance *SJ*, at *R* a distance *RK*, and at *P* a distance *PL*. At *N* the valve will be in mid-position and will then pass below and reach a distance *AV* at the end of the stroke with piston at *A*. On the return stroke the valve will pass through a similar series of locations, determined by the distances from *AB* downward to the curve. With this arrangement of diagram the movement of the valve above mid-position is laid off above the line *AB*, and similarly for the movement below mid-position. With an outside valve this shows above the line *AB* the events for the up stroke and below the line the events for the down stroke. With an inside valve the diagram is reversed and the events for the up stroke are shown below the line and for the down stroke above the line.

We have already seen that, starting from mid-position, the valve must move a distance equal to the steam lap before the port begins to open for steam. Suppose, then, that *BF* is laid off equal to the steam lap on the lower end of the valve, and a line *FL* drawn parallel to *BA*. Then it is clear that the remaining distances from *FL* upward to the curve *ZTKL* give the distances which the edge of the valve travels beyond the first edge of the port, and hence, if the port is sufficiently wide, the actual widths of port opening. At *R* the furthest distance is reached, and the edge of the valve is at a distance *OK* beyond the first edge of the port. It is clear that the distance *RK* is the throw of the eccentric, and that this is equal to the lap plus the greatest width available for port opening. If the width of the port is equal to or greater than *OK*, then the total movement *OK* can be utilized for opening, and this will be its greatest value, while the various distances from *FL* to *ZTKGL* will give the entire history of the width of port opening for corresponding positions of the piston. Very often, however, the width of port is less than the distance *OK*. In such a case draw a line *IJ* parallel to *LF* and at a distance from it equal to the width of the port. Then it is clear that the widths of port opening will be given by the distances from *FL* to the lines *ZTJIL*. Full opening is reached at *J* or with the piston at *S*. This continues to *I*, or until the piston reaches *Q*. The port closes at *L*, or when the piston reaches *P*. This is therefore the point of cut-off or steam closure. Similarly the port opens at *Z* just before the end of the stroke, and at the end is open a distance *FT*, which therefore represents the steam lead.

Having thus obtained a general idea of the nature of this diagram, let us examine by its aid the effects of a change in the steam lap. This corresponds to raising or lowering the line *FL*, and it is readily seen that the results of an increase, for example, are as follows:

(1) Earlier cut-off.
(2) Steam opening nearer the end of stroke.
(3) Decreased lead.
(4) Decreased port opening all the way through.

The results of a decrease of lap are, of course, in the opposite direction respectively.

In a similar manner we may examine the operation on the exhaust side of the valve. This is illustrated in the same figure, where *MY* is the lap line laid off at a distance *BD* from the center line, equal to the exhaust lap on the upper end of the valve; that is, on the end which opens the port to exhaust by moving above the mid-position. It is thus seen that the valve opens to exhaust at *Y* with the piston at a distance *YD* from the end of the stroke, while at the end of the stroke it is open a distance *DT*, the exhaust lead. Then during the following stroke the distance of the exhaust edge of the valve from the corresponding edge of the port is given by the distance from *DM* to the curve *TKLM*. At *M* the port closes, and for *MC*, the remainder of the stroke, the steam undergoes compression in the cylinder. Usually the width of the port is somewhat less than the total distance available, so that the full movement of the valve cannot be utilized for actual opening. In such case draw a line *GH* parallel to *MY*, and distant from it an amount equal to the width of port. Then full opening is reached at *H* with piston at *W*, and continues to *G* with piston at *U*, the openings for the remaining portions of the stroke being given by the distance from *MD* to *YTH* and *GM*.

An increase of exhaust lap is readily seen to produce the following results:

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(1) Earlier exhaust closure and longer compression.
(2) Exhaust opening or release later or nearer the end of stroke.
(3) Decreased exhaust lead.
(4) Decreased port openings or decreased time during which the port is wide open.

A decrease of exhaust lap will, of course, produce results in the opposite direction.

We have thus far been concerned with the influence of an increase or decrease in the steam or exhaust lap. It remains to examine the influence due to a change in the angle δ, the angular advance. If this angle is increased and the new series of valve movements plotted as in Fig.

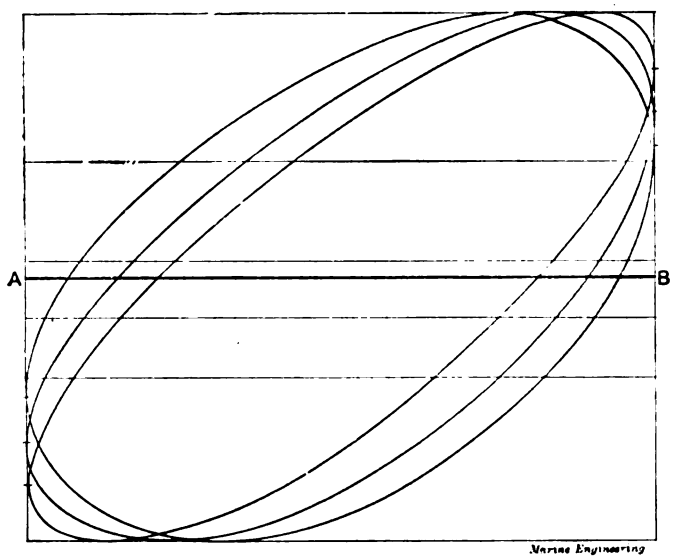

FIG. 15.—OVAL VALVE DIAGRAMS.

14, it will be found that the oval becomes narrower and touches the boundary lines nearer the corners, as shown in Fig. 15. Similarly with a smaller value of δ the valve oval will become wider or rounder, and will touch the boundary lines further from the corners, likewise as shown. Remembering this and comparing Figs. 14 and 15, it is readily seen with the same values of the lap that changes in the various quantities will take place as shown in the tabular arrangement below. This table shows at a glance the variation in the various events due to change in the three items above the double line, as explained in the foregoing.

TABLE SHOWING EFFECT OF VARIATION OF ANGULAR ADVANCE AND LAP.

Angular Advance	Increase.	Decrease.				
Steam Lap			Increase.	Decrease.		
Exhaust Lap					Increase.	Decrease.
Steam Opening	Earlier.	Later.	Later.	Earlier		
Steam Closure	Earlier.	Later.	Earlier.	Later.		
Steam Lead	Increase.	Decrease.	Decrease.	Increase.		
Exhaust Opening	Earlier.	Later.			Later	Earlier.
Exhaust Closure	Earlier.	Later.			Earlier.	Later.
Exhaust Lead	Increase.	Decrease.			Decrease.	Increase.
Greatest Port Opening	Same.	Same.	Decrease.	Increase.		

Attention may also be called at this point to the diagram of Fig. 16, in which the various quantities for an outside valve are lettered and named in position. A careful study of this figure in connection with the valve positions of Fig. 4 will be of great aid in acquiring a good understanding of the operation of a slide valve, and of its representation by means of such a diagram.

If the measurements for the diagram are taken from an actual engine or from a properly constructed model, it will be found, as already noted, that for the down stroke the curve is more humped or rounded than for the up stroke, as shown in the figures above. That is, for

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the same relative positions of piston the valve will be further from the center line on the down than on the up stroke. This is an effect due to the angularity of the connecting rod of the engine, and it results that the various points of opening and closure, and the values of lap, lead, and port opening, cannot be made the same for both strokes. As is shown by the diagram, the cut-off is usually later on the down than on the up stroke, and it cannot be equalized without a serious derangement of the other events. Instead of attempting to equalize any two features, such as steam lead, cut-off, or port opening, it is usually better to so adjust the steam and exhaust laps above and below that the resulting combination of events shall represent the best compromise possible under the circumstances. If it were not for the effect due to the angularity of the connecting rod and valve rod, the curve would be an ellipse, and the distribution of the events for both strokes could then be made the same.

[10] Simple Eccentric Valve Gear.

We have already studied the movement of a valve due to a single eccentric, and the representation of this motion by means of various diagrams. It only remains to note a few points regarding the various combinations and arrangements in which this gear may be found.

In Fig. 17 we have the simplest and most common form, consisting of an outside valve direct-connected to the eccentric. We have already seen that, starting with the valve in mid-position, it must move a distance equal to the steam lap before the port will begin to open for steam, and hence at the end of the piston stroke the valve must have already moved from its mid-position a distance equal to the steam lap plus the lead. Suppose now that the eccentric is loose on the shaft and may be adjusted as desired. In Fig. 17 let C denote the crank on the center. Then suppose the eccentric first located 90 degrees ahead of OC, as shown at OA, where $OA = OB =$ eccentric throw. Then, neglecting the slight effect due to the obliquity of the eccentric rod, the valve will be in its mid-position, as shown in Fig. 1. Next, move the eccentric ahead until the valve has moved a distance equal to the lap plus the lead, as in Figs. 2, 17. This gives the final location of the eccentric for the proper operation of the valve, as al-

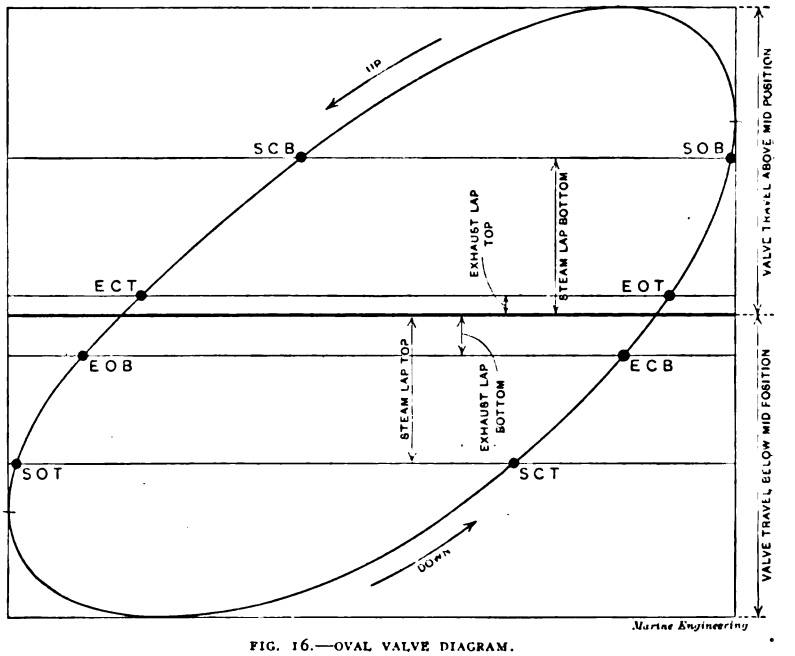

FIG. 16.—OVAL VALVE DIAGRAM.

$S\,O\,B =$ Steam Opening Bottom.
$E\,O\,T =$ Exhaust Opening Top.
$E\,C\,B =$ Exhaust Closure Bottom.
$S\,C\,T =$ Steam Closure Top.
$S\,C\,B =$ Steam Closure Bottom.
$E\,C\,T =$ Exhaust Closure Top.
$E\,O\,B =$ Exhaust Opening Bottom.
$S\,O\,T =$ Steam Opening Top.

ready described. The angle AOB, through which it is thus necessary to move the eccentric in order to effect this movement of the valve from its mid-position, or more exactly the angle between the eccentric and the line at right angles with the crank, we have already termed the angular advance, denoted by δ, while the entire angle between crank and eccentric is thus 90 degrees $+ \delta$

In regard to the direction of motion of the crank, it is clear that when the piston is at the

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end of the stroke and the crank on the center, the latter must start off in such direction as will increase rather than decrease the opening of the port for steam. If the connections and arrangements of a valve gear are known, no matter how complicated, this principle will always furnish an answer to the question as to the direction in which the engine will turn. Thus in a direct-connected gear, as in Fig. 17, with the piston at the end of the stroke, the crank moves in the same direction as the eccentric, or follows it, simply because that is the direction which opens the port still wider for steam admission. With an inside valve the eccentric is set at 180 degrees behind, or directly opposite the position for an outside valve, as shown in Fig. 18, or at OB_1, Fig. 17. In such case the angle between the crank and eccentric is 90 degrees $-\delta$,

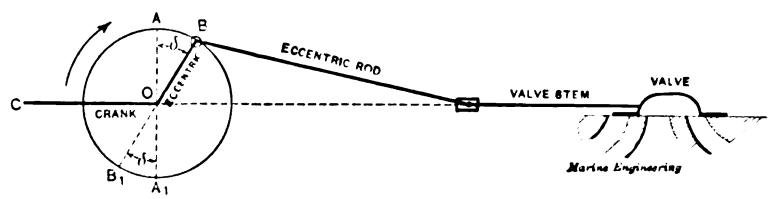

FIG. 17.—DIAGRAM SHOWING CONNECTIONS FOR SIMPLE VALVE GEAR.

or the angle δ is set off toward the crank from the 90 degree position. It is readily seen that this will bring the valve slightly open when the piston is at the end of the stroke, and that the crank will move leading the eccentric, because this is the direction which opens the port wider for steam admission. It is also seen that to fulfill the same purpose the piston and valve at the end of the stroke must move in opposite directions.

In some cases the valve rod, instead of being directly connected to the eccentric rod, is worked through a rocker arm, which reverses the motion as compared with the direct-con-

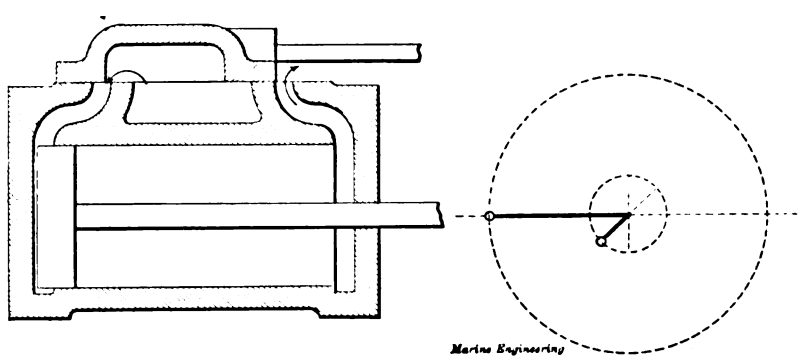

FIG. 18.—INSIDE VALVE AND LOCATION OF ECCENTRIC

nected gear. See Fig. 19. This provides a second mode of variation which may affect the arrangement of a valve gear, giving in all four combinations, as shown in the following table:

Valve.	*Connection*	*Angle Between Crank and Eccentric.*	*Which Leads.*
Outside	Direct	$90 + \delta$	Eccentric leads
Inside	Direct	$90 - \delta$	Crank leads
Outside	Rocker	$90 - \delta$	Crank leads
Inside	Rocker	$90 + \delta$	Eccentric leads

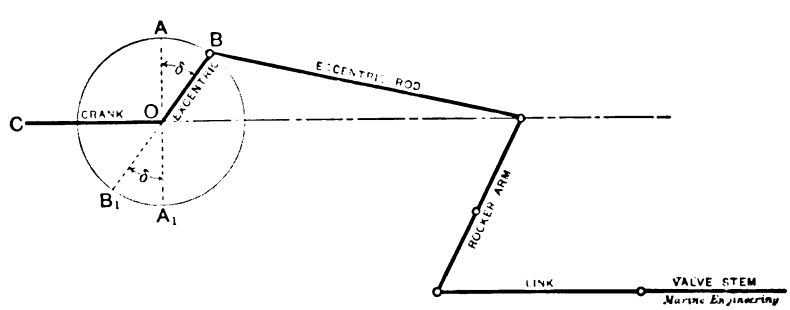

FIG. 19.—DIAGRAM FOR VALVE CONNECTIONS THROUGH A ROCKER ARM.

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TECHNICAL PUBLICATIONS.

The Manufacture of Iron and Steel Tubes. Second and enlarged edition. By E. C. R. Marks. Size 5 by 7 1-2 inches. Pp. 156, with 133 figures in the text. The Technical Publishing Company, Ltd., Manchester, England. Price $1.25.

The first volume of this book comprised the development of a special course of lectures delivered in 1897 by the author during a session of the Birmingham Municipal Trade School. The second edition contains the original matter, with the needed revision regarding various patents referred to.

In addition the eighth and following chapters contain further particulars regarding the manufacture of iron and steel tubes, with reference to such British patent specifications published between the two editions as relate to the process under consideration.

An appendix is also given which, while not completely exhaustive, still contains the numbers of most of the patents which have been granted for such purposes, and should therefore be found useful to manufacturers and others as affording a ready and convenient key to the state of the art.

The subject matter of the book, together with the illustrations, is based on the printed patent specifications, and together they furnish, therefore, a comprehensive presentation of the development of the art of tube-making as indicated by the efforts of inventors in this field.

The chief feature which must be regretted in the book is the absence of more extended comment and criticism regarding the various methods and processes, and some indications regarding those which have actually proved their practical value and which have been in the past or now are in actual use, and those, on the other hand, which have not affected the actual art of tube manufacture, but have appeared only as inventors' proposals. The student of any industrial art, such as that of tube-making, is of course interested in the efforts of inventors, and in such part of the history of the art as is shown by the Patent Office records. He is still more interested, however, in those methods which have proved to be of chief industrial value, and which have left their imprint most deeply on the actual practice of the art. In a book such as the present the discrimination and criticism needed in order to give the latter information would be a matter of some delicacy and requiring much judgment and an intimate acquaintance with the practical field. Such information would, however, have added greatly to the practical value of the book to all concerned with this field of industry.

Judged from the author's purpose, the work seems to have been carefully done, and to give in condensed and yet clearly understood form a large amount of information regarding all patents of importance in this department of industrial art.

Friction and Lubrication. By Wm. M. Davis. Size 5 1-2 by 8 inches. Pp. 225, with 60 figures in the text. Lubrication Publication Company, Pittsburg, Pa. Price $2.00.

The author of this book is a practical man and has gathered together a large amount of information regarding friction and lubrication, which he presents in a well-arranged and usually clear manner. The book opens with a discussion of friction and its laws, and is followed by a large amount of information regarding friction losses in engines and in various kinds of machines, the results regarding which he has collected from various reports and scientific publications. In connection with the author's definition of rolling and sliding friction, it may be remarked that the definition of the former as the friction of a journal in a bearing, and of the latter as that of a crosshead on its guide, is hardly in accord with the accepted use of these terms. Fundamentally the friction of a journal revolving in its bearing and of a crosshead moving on its guide are the same. They are both sliding friction. Rolling friction, on the other hand, is a term used to denote the form of resistance encountered due to the rolling of a wheel or cylindrical support on a track or other like surface, and may be illustrated by the resistance due to the action at the point of contact between the wheels of a railway car and the rails.

Following the discussion of friction and the losses due to its manifestation, the author discusses briefly the general principles of lubrication. This chapter, in so far as it has to deal with fundamental principles, is hardly abreast of the latest thought on the subject. The results of relatively recent studies on the distribution of pressure in the oil film, together with the relation of such results to the general problem of lubrication, are not referred to, and such references as are made to fundamental principles are hardly satisfactory from the modern point of view. Thus the action of the lubricant is stated to be similar to that of a cushion filling up the interstices and covering up the high spots. Reference to the fundamental fact of film tension is not made, without which lubricating action would be impossible, and at the same time cohesiveness and viscosity are used as practically equivalent terms.

Following this chapter the author gives a description of the various tests to which oil may be subjected and of the machines and apparatus by means of which such tests may be carried out. This section of the book is then followed by a discussion of practical lubrication as carried out with the steam engine, with machinery of various representative types, rolling stock of railroads, etc. This is accompanied with cuts and descriptive matter relating to all manner of devices and arrangements for feeding oil or lubricant under the various conditions and for the various purposes under consideration.

The book closes with reference to bearings and journals and the properties of various bearing metals and alloys, to ball and roller bearings, to the treatment of hot bearings, and to the gauging of oil barrels and to the various points connected with the practical care of an oil house for a large industrial establishment.

The author has shown industry and generally good judgment in gathering together the matter which he presents, and to all interested in the problems of lubricants and lubrication the book will be found of interest and distinct value, especially as regards the practical points drawn largely by the author from his own experience.

Index of the Technical Press. Association de la Presse Technique, 20 Rue de la Chanselarie, Brussels. Size 9 1-4 by 4 1-8 inches. 292 pp. Issued monthly. Price $1 a year.

As the technical press which reflects the lines of thought and research of the day is so voluminous, en-

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gineers and others who wish to keep posted have a difficult task before them if they are to peruse all the technical journals. The Association de la Presse Technique is publishing in concise form a monthly *Index* of all articles relative to science and technical matters appearing in the technical papers throughout the world. The *Index* is printed in three languages, namely, English, French, and German. For the résumé of those journals published in languages of Latin origin and in Russian the French language is employed; Scandinavian and Dutch journals are indexed in German.

The *Index* gives the author's name, the name of the article and the volume in which it is published, and its length, also classification number according to the universal classification system of Brussels. Thus one may read the names of all articles appearing in the branches in which he is especially interested, and, if he so desires, obtain from the Association the desired copies of the articles translated in any language at a small cost. If these indices are pasted on cabinet filing cards, which so many individuals and companies are using to-day, they form a ready and valuable reference. This will be found to be a very valuable asset to the busy professional man's library.

Manning's Yacht Register, 1903. Manning's Yacht Agency, 45 Broadway, New York, N. Y. Size 10 by 7 3-4 inches. In two parts. Part I. 248 pp., Part II. 304 pp. Price $10.

The new edition of Manning's Yacht Register, for the present year, presents a very attractive form bound in white duck. The issue is in two volumes, the first of which contains a complete register of the recognized yacht clubs throughout the United States and British provinces, and also the Royal Jamaica and Argentine Yacht Clubs; full lists of officers of the yacht clubs, names of yachts, official numbers, signal letters, dimensions, by whom built, designed, and owned; and general dimensions and particulars of all sail and steam yachts. Then follows a list of yachts the names of which have been changed and the yacht owners. The first volume is very fully illustrated with fac-similes in colors of club flags and private signals of owners. Part II. contains a report regarding the yacht club regattas and races for 1902, compiled from official sources, showing names of yachts, racing lengths, time allowance, rules of the different clubs, weather in which the race was sailed; also course distances, the number of trials in each case, times of starting and finishing, together with elapsed and corrected times and results, and in fact all particulars about the races. Reports are also compiled of the America's, Cape May, and Brenton's Reef Challenge Cups. In fact these books contain full reports of American yachts and yachting.

The Art of Pattern-Making. By I. McKim Chase. Size 5 inches by 7 1-2 inches. Pp. 251, with 215 figures in the text. John Wiley and Sons, New York. Price $2.50.

The subject matter of this book is taken largely from the personal experience of the author with the art of pattern-making in its various branches, supplemented by the experience of others in various special parts of the field. The contents include chapters on the equipment and management of a modern pattern shop, followed by a wide range of typical and special illustrations of patterns met with in various fields of engineering work, and for molding in loam and sand both dry and green. Among these may be mentioned: the steam cylinder of a marine engine, screw propellers in loam and in sand, both with solid and separable blades, belt pulleys and flywheels, gear teeth, gun-mount pedestal, etc. These are followed by chapters on various special matters of interest and importance to the pattern maker, such as: the use of a wood lathe; how to make a wooden face plate; making, recording, and storing patterns; making special shrinkage rules; wax fillets; together with various rules for computation, geometrical constructions used in drawing, standard conventions for section lining, etc.

The book is written in a plain and simple style and the explanations are in general quite clear. Here and there carelessness in the letters referring to drawings is noticeable, but as a rule the meaning is clear.

The literature relating to pattern-making is not large, and this contribution, from one whose active life has been so largely spent in immediate contact with such work, should prove of distinct value to all practical workers in this field.

1903 Blue Book of American Shipping. By the Marine Review Publishing Company, Cleveland, Ohio. One volume of 468 pp., 10 by 7 inches. Price $5.

The value to the business man of correct lists of individuals and companies in his special line is well recognized. This year's volume of the Blue Book forms a most worthy reference book on marine subjects. It contains names of officers and individuals of all maritime trades, such as naval architects, marine superintendents, marine engineers, shipowners, shipchandlers, shipmasters, etc. Especially does this book cover the industry of the Great Lakes. Much valuable information is given concerning lake shipping. There is also a list of all the American steam and sailing vessels of the Great Lakes. Valuable tables are compiled concerning the trade on these great inland waters, such as the iron ore carried from the different districts, railway facilities, transportation rates, movement of grain, etc. A complete list is given of the dry-docks, marine railways, shipbuilders, and steamship companies throughout the country, also names and addresses of the yacht owners of the United States, yacht clubs and admiralty lawyers. The book is printed on heavy coated paper and is illustrated with engravings of many of the new types of vessels.

The Drafting of Cams. By Louis Rouillion. Size 6 1-2 by 8 inches. Pp. 24. Paper bound. The Derry-Collard Company, 256 Broadway, New York, N. Y. Price 25 cents.

This is the second in a series of practical papers published by the company relating to machine design. Each one of the series is written by a practical man and is intended to meet the wants of draftsmen or machinists wishing to learn the essential way of laying out cams. The use of the cam is first described, then the method of laying out the different forms, well illustrated with clear cuts. The treatise is divided under the two heads of cams where the line of action is central and where it is not central. The paper is completed by illustrating a problem in designing a belt shifter. The method in which the books of this company are sold permits one to first examine the book before paying for same. If it does not meet with approval it may be returned.

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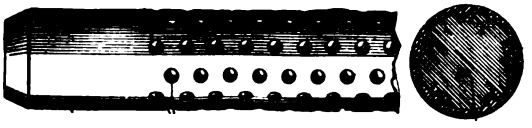
SELECTED MARINE PATENTS.

736,891. MEANS FOR PROTECTING SUBMERGED DEVICES. OMAR A. STEMPEL, LAKELAND, FLA., ASSIGNOR OF ONE-HALF TO CHARLES M. MARSH, LAKELAND, FLA.

Claim.—1. An object adapted to be submerged in water, having series of individually-formed key seats with inclined walls, the walls of alternate series being inclined in reverse direction, and a covering applied over the object and forced into the said seats.

2. An object adapted to be submerged, having series of individually-formed key seats therein, a coating of protective paint applied over the object and run into the seats, and a covering applied over the object on the coating of protective paint and forced into the seats. Two claims.



736,747. LIFEBOAT. AUGUSTO LASERRE, BUENOS AIRES, ARGENTINA.

Claim.—A lifeboat having its bottom provided with a vertical drain channel disposed between longitudinally-ranging tanks, and a weighted metallic keel depending from the bottom of the boat and disposed in the vertical plane of the drain channel therein, said weighted keel being provided with vertical and transverse slots which communicate with each other and also have communication with the drain channel. One claim.

736,772. PORT LIGHT. CHRISTIAN F. PETERSEN, WILMINGTON, DEL.

Claim.—1. The combination of a main or body portion having a port opening and a packing gasket surrounding the same, a glass and glass frame, the latter being arranged to bear on said gasket, means for holding the glass frame in position, substantially as described, the said glass frame comprising two rings screwed together with an internal packing gasket fitting between them, said rings having inwardly-extending flanges embracing the top and bottom sides of the glass.

2. A port-hole cover comprising a cover proper of concavo-convex cross-sectional form, a swinging arm connected with the central portion of the cover, a link formed of adjustable sections, and a cam lever mounted on the link and adapted to engage the free end of the arm. Eight claims.

736,428. SOUND-PRODUCING DEVICE SUITABLE FOR SIRENS OR LIKE INSTRUMENTS. JOHN P. NORTHEY, TORONTO, CANADA. Four claims.

738,190. MEANS FOR GUIDING BOATS PROPELLED BY ELECTRIC OR OTHER POWER. HENRY HEALY, BUFFALO, N. Y.

Claim.—1. In an electric system of canal propulsion, the combination with a waterway and a boat, of a series of trolley poles located along the line of the waterway for supporting a feed wire, guide rails arranged upon opposite sides of the trolley poles beneath the feed wire, an arm secured to the side of the boat, means carried by said arm for engagement and travel upon the guide rail, and electrical communication between the boat and the feed wire.

2. In a system of canal propulsion, the combination with a waterway and a boat, a guide rail, a plate slidably and adjustably mounted upon one side of the boat, said plate having an offset projection, an arm hingedly connected to said projection, and means carried by the free end of the arm for engagement and travel upon the guide rail. Three claims.

738,206. SEMI-SUBMERGIBLE VESSEL. SIMON LAKE, BRIDGEPORT, CONN.

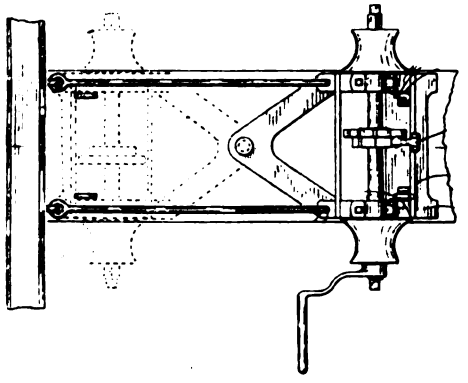
Claim.—1. A vessel having one end constructed and adapted to float permanently at the surface of the water and the opposite end normally buoyant, but provided with means whereby it may be caused to sink beneath the surface.

4. A vessel having one end adapted and constructed to be maintained permanently at the surface of the water and provided at or near the other end with a diver's compartment having doors communicating, respectively, with the exterior and interior of said vessel, an adjacent water-ballast compartment, and means whereby water may be admitted to or expelled from said water-ballast compartment. Five claims.

738,221. SHIP'S-COURSE RECORDER. WILLIAM MAXTED, WERNERSVILLE, PA.

Claim.—1. A ship's-course recorder comprising a compass box, a stationary card arranged within the compass box, and a vertically-movable compass card carrying a marking device adapted to record the course of the ship upon the card, as specified. Five claims.

738,348. WINCH FOR FISH BOATS. JOHN J. McDONALD, PORT MADISON, WASH.



Claim.—1. An apparatus of the class described, comprising, in combination, a frame having end standards and a base plate, a shaft journaled in said frame ends and carrying spools and a gear wheel, another shaft journaled in said frame ends and having a pinion mounted thereon which meshes with the said gear wheel, a trunnion extending through the said base plate and pivotally connecting the frame to a supporting platform or boat-thwart, staples connected with said thwart and adapted to engage with the same frame, locking keys for said staples, and the stay rods. Two claims.

738,359. BOAT. GRENVILLE H. ROOD, WASHINGTON, D. C. Twelve claims.

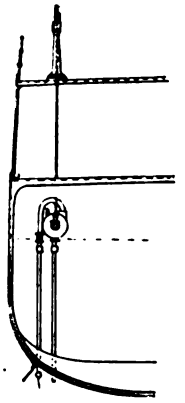
738,400. DETACHABLE LIFERAFT FOR SHIPS. BENJAMIN W. BOOKER, BERKELEY, CAL.

Claim.—1. The combination with the hull of a vessel of a detachable life-saving superstructure; guides on the vessel between which said structure is supported; collars or caps secured to the under side of the deck of the vessel, and projections on the bottom of the superstructure fitting said collars or caps, said collars or caps and projections perforated coincidently; locking pins engaging said collars or caps, and projections and means whereby the pins are actuated in unison to release the parts. Three claims.

738,436. WATER VEHICLE. HENRY A. HANSEN, NEW YORK, N. Y., ASSIGNOR OF ONE-HALF TO PAUL OLSEN, NEW YORK, N. Y.

Claim.—1. A water vehicle comprising a main frame, a propeller float mounted longitudinally in the bottom thereof and provided with a shaft, said propeller float being circular in cross section and pointed at the front end, and provided with a spirally-arranged propeller, devices for turning the propeller float, a support at the front of the main frame, a rod passing vertically therethrough, a steering float connected with the lower end of said rod, a handle bar connected with the main frame, and devices whereby said handle bar is put in operative connection with the steering float. Three claims.

738,458. APPARATUS FOR INDICATING SPEED OF



VESSELS. SIDNEY J. LAWRENCE, CHRISTCHURCH, NEW ZEALAND.

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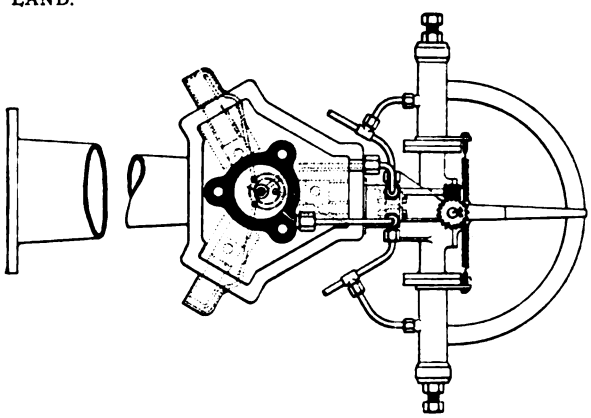
Claim.—1. The combination in apparatus for the purpose indicated of a turbine motor, a pipe communicating with the inlet port of said motor extending through the hull, and having a bend projecting toward the bow of the vessel, a pipe communicating with the exhaust port of said motor and extending through the hull of the vessel, a bevel wheel upon the spindle of said motor gearing with a bevel pinion upon a vertical spindle extending up through the deck of the vessel, and means for actuating indicating gear by the revolution of said vertical spindle. Three claims.

738,595. MOORING DERRICK SCOWS IN RAFT CONSTRUCTION. JOHN AYRES, PORTLAND, ORE., ASSIGNOR TO OREGON RAFTING COMPANY, PORTLAND, ORE., A CORPORATION OF OREGON. One claim.

738,695. BOW-FACING OAR. ELI S. McCAULLEY, MONTOUR, IOWA, ASSIGNOR OF ONE-HALF TO THOMAS U. FRANTZ, MONTOUR, IOWA. Three claims.

738,725. SYSTEM OF SUBMARINE COMMUNICATION. SIMON LAKE, BRIDGEPORT, CONN. Five claims.

738,767. TELEMOTOR APPARATUS FOR SHIPS OR THE LIKE. ANDREW B. BROWN, EDINBURGH, SCOTLAND.



Claim.—1. A telemotor apparatus comprising a hydraulic cylinder and piston, and pipes leading thereto, in combination with mechanism for forcing fluid through said pipes, consisting of three single-acting pumps and a distribution valve connected therewith, a hand-wheel shaft and parts for operating such pumps and valve therefrom, two cylinders, a spring-controlled plunger in such cylinders, two pointers, gearing connecting the plunger with one pointer and the second with the hand-wheel shaft, a clutch connected with the second pointer, with means for putting it into and out of gear on the movement of the first pointer, and pipe connections leading to the hydraulic cylinder and also to the plunger cylinders substantially as described. Three claims.

738,879. AUTOMATIC DIVING MECHANISM FOR SUBMARINE BOATS. FRANCIS W. BRADY, ENGLEWOOD, N. J., ASSIGNOR TO ELECTRIC BOAT COMPANY, NEW YORK, N. Y., A CORPORATION OF NEW JERSEY. Four claims.

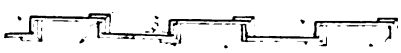
738,985. PROPELLER. EDUARDO CLAUDIO, RIO JANEIRO, BRAZIL. Two claims.

738,996. WAVE MOTOR. FERDINAND J. HAGEN, NEW YORK, N. Y. Five claims.

739,033. SHIP LOADING OR COALING DEVICE. JULIUS TARR, PHILADELPHIA, PA.

Claim.—1. In a device of the character described, a boom pivoted to the deck of the vessel, guy ropes for adjusting and securing the boom in place, a cable secured at one end to another vessel or to the land, this end being secured at a point lower than the upper end of the boom, said cable passing over a roller journaled in the upper end of the boom and also over a roller secured to the mast of the vessel, a weight suspended upon this end of the cable, a traveler designed to travel along said cable, a cable secured to said traveler, a bucket or other receptacle suspended from said cable, said cable passing from the traveler over a pulley upon the boom downward to a winding apparatus, means for releasing the bucket so as to allow the same to descend when it has reached its destination. Two claims.

739,072. SHEET PILING. LUTHER P. FRIESTEDT, CHICAGO, ILL.

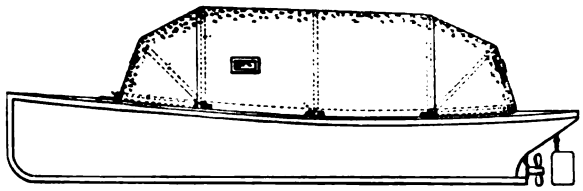


Claim.—1. A metal sheet piling, comprising beam sections joined edgewise and carrying means for transmitting a retaining pressure from the earth walls as the sections are forced into place. Six claims.

739,302. BOW-FACING OAR. JOSEPH P. FRETWELL AND JAMES T. BROWN, PENASOFFKEE, FLA. One claim.

739,389. STORM HOOD AND COVER FOR LAUNCHES. ARTHUR H. CASTLE, MINNEAPOLIS, MINN., ASSIGNOR OF ONE-HALF TO S. M. HAUSER, MINNEAPOLIS, MINN.

Claim.—1. The combination, with a launch deck and coam-



ing, of a plurality of ribs or bows curved to conform substantially to the curve of the coaming at the end of the cockpit and adapted to drop down upon the deck outside of said coaming, the ends of said bows being pivotally secured, a flexible material covering and connecting said bows, means for securing one of said bows at a point intermediate to its ends in a horizontal position on the deck, and means for supporting the other bows in a raised position and drawing said covering taut between them and said horizontal bow. Four claims.

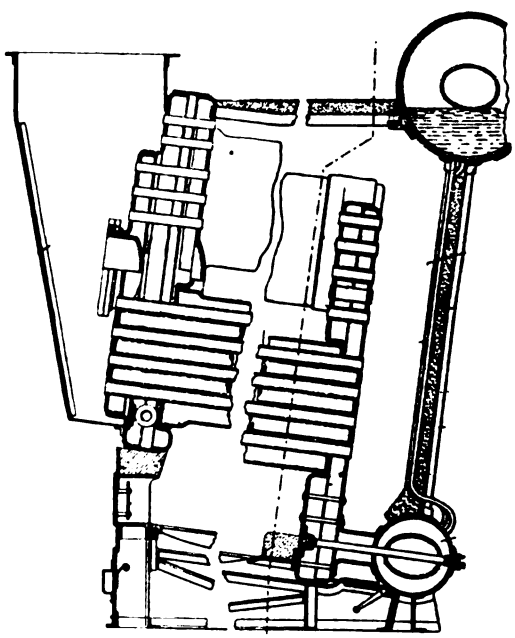
739,475. RANGE FINDER OR TELEMETER. ARCHIBALD BARR, GLASGOW, SCOTLAND, and WILLIAM STROUD, LEEDS, ENGLAND. Three claims.

739,734. SUBMARINE BOAT. LAWRENCE Y. SPEAR, GREENPORT, N. Y., ASSIGNOR TO ELECTRIC BOAT COMPANY, A CORPORATION OF NEW JERSEY. Six claims.

739,735. COMPENSATING DEVICE FOR SUBMARINE OR SUBMERGIBLE BOATS. LAWRENCE Y. SPEAR, GREENPORT, N. Y., ASSIGNOR TO ELECTRIC BOAT COMPANY, A CORPORATION OF NEW JERSEY. Five claims.

739,775. BOAT OR VESSEL. HYRAM J. BAYARD, CHICAGO, ILL. Four claims.

740,270. MARINE BOILER. PAUL GRÜNEWALD, DUISBURG, GERMANY.



Claim.—1. A boiler comprising front and rear transversely-extending water chambers, large longitudinal water tubes connecting the chambers with each other at their inner adjacent faces, smoke-return flues extending longitudinally through the said water tubes and through the outer faces of the water chambers, and short smoke flues extending longitudinally through each of the water chambers.

2. A boiler, comprising front and rear transversely-extending water chambers, large longitudinal water tubes connecting the said chambers with each other, smoke-return flues extending longitudinally through the water tubes and through the outer faces of the water chambers, a transverse mud drum in the rear of the rear water chamber and connected with the lower end thereof, a transversely-extending steam drum in the upper part of the boiler, stand pipes supporting the steam drum and connecting it with the mud drum, and pipes connecting the mud and steam drums and forming the rear wall of the boiler. Six claims.

740,317. MARINE TORCH. WILLIAM H. ROSE, BALTIMORE, MD., and JAMES A. WATSON, WASHINGTON, D. C., ASSIGNORS TO THE MARINE TORCH COMPANY OF BALTIMORE CITY, BALTIMORE, MD. Seven claims.

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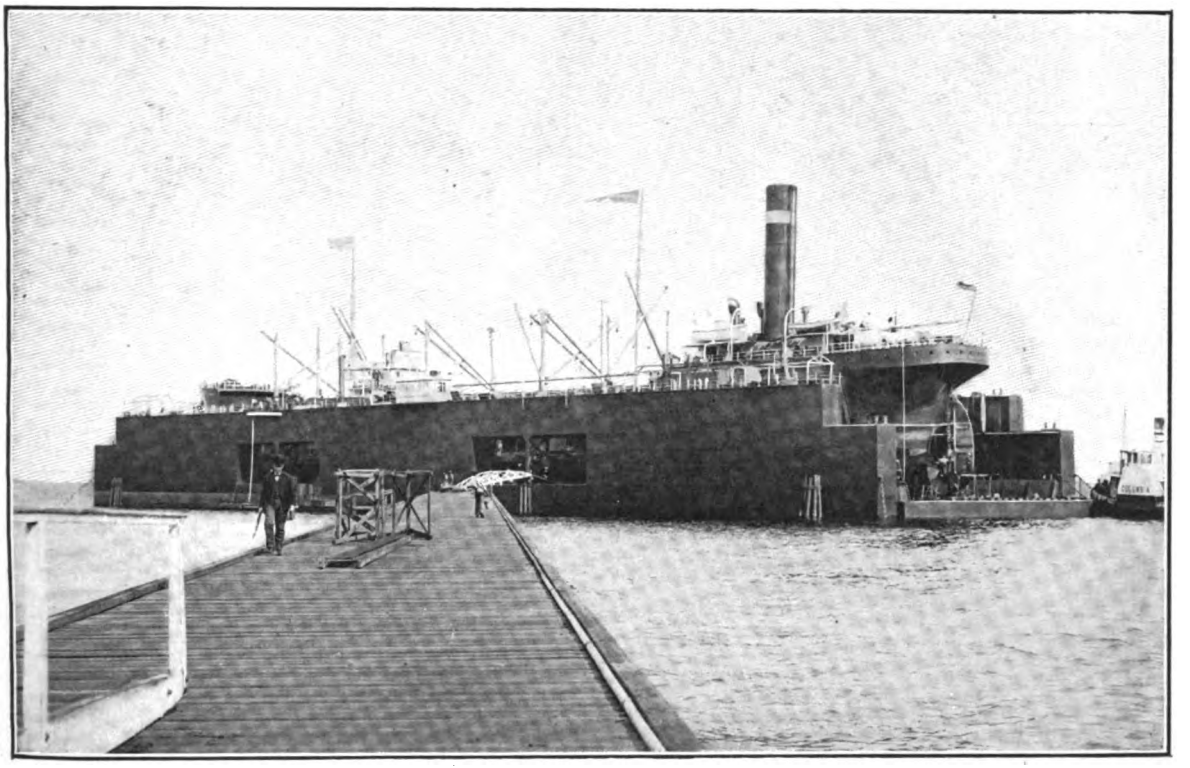
Marine Engineering

Vol. VIII. NEW YORK, DECEMBER, 1903. No. 12.

HAVANA FLOATING DRY-DOCK NOW AT NAVY YARD, PENSACOLA, FLORIDA.

The passing of the Havana dry-dock, built for the Spanish Admiralty for use in Havana harbor before the late war, from one country to another and from one port to another, its collapse, repair, and final successful use, makes as interesting a chronicle of events in the life of an ordinary dry-dock as could be found in the history of many a merchant or war ship.



10,000-TON FLOATING DRY-DOCK NOW AT PENSACOLA NAVY YARD, WITH FREIGHT STEAMER AUGUST BELMONT.

Before the dock was finished Cuba as well as the Philippines came under our protection, and Spain had no more use for the dry-dock, so in 1901 our government decided to purchase this dock as an expression of our friendly post-bellum feeling for Spain. It was primarily intended to tow the dock to the Philippines, but this plan was changed as it was decided to build a larger one for that service. The government continued using this dock at Havana successfully for some time until it became necessary to clean the pontoons.

The dock was built by C. S. Swan and Hunter, Limited, at Wallsend-on-Tyne, and the machinery was installed by Ernest Scott and Mountain Smith, Newcastle-on-Tyne, while the designs were prepared by Clark and Standfield. It is of the usual self-docking pontoon type, composed of two side walls and five pontoons. Each side wall and pontoon is divided into five water-tight compartments; thus there are thirty compartments in all. Any pontoon can be raised by the others, thus facilitating repairs and cleaning, while the bottom of the side walls may be reached for the same purpose by simply careening. In this manner the whole structure may be kept in first-class condition. The dock has adjustable bilge blocks, capable of being shifted in or out as well as longitudinally.

The general dimensions are as follows: length over all, 450 feet; breadth inside of walls, 87 feet 7 inches; water over sill, 27 feet 6 inches; number of pontoons, 5; weight, 4,400 tons; lifting capacity, 10,000 tons. The plating is of 15 pounds weight, while the angles are 6 by 3 by 10-20 inches, well secured by numerous brackets. A sketch may be seen on page 598. The machinery consists of two 200-horse-power locomotive

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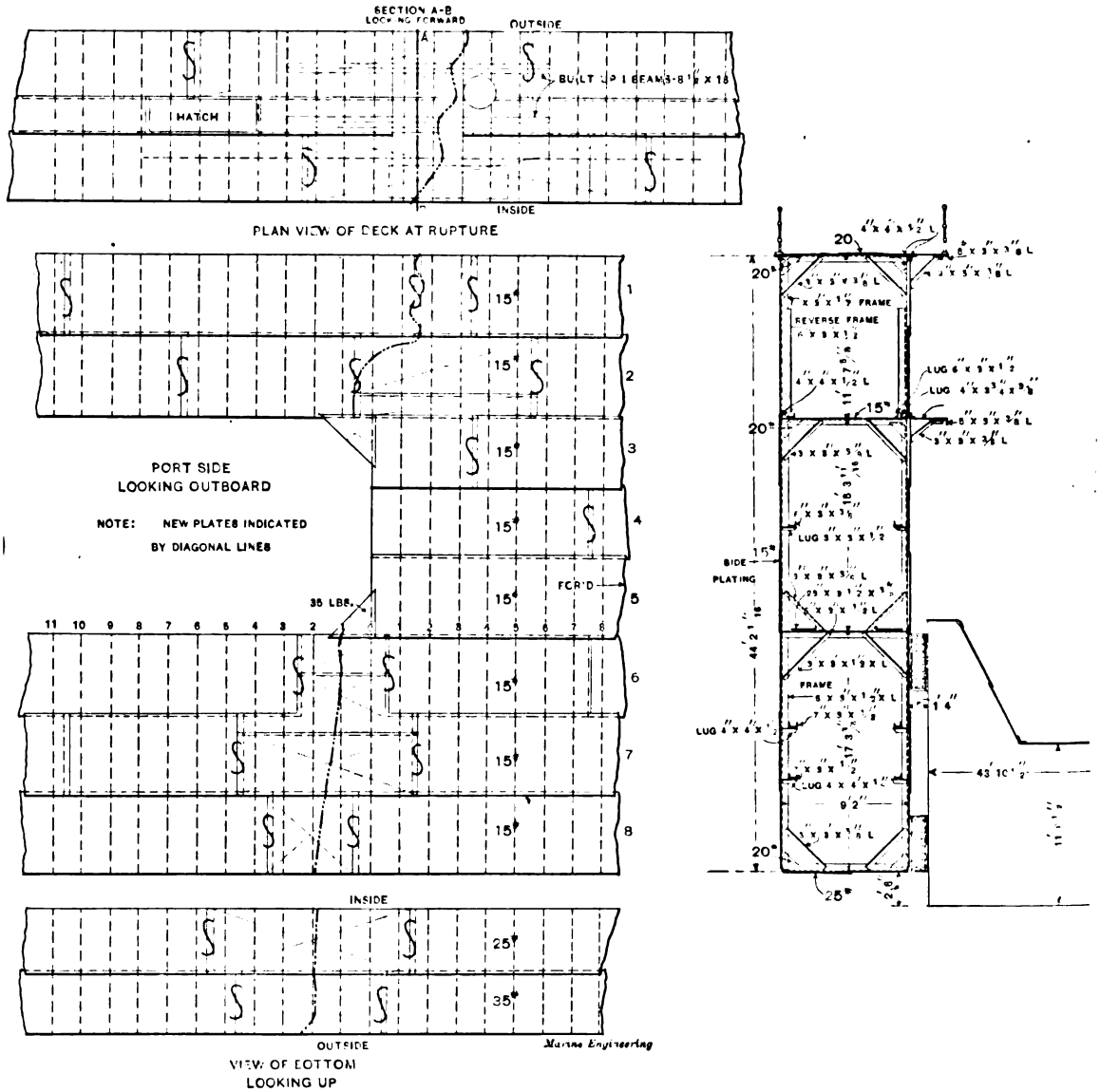
boilers supplying steam to two vertical, compound engines direct-connected to 125 Kw. direct-current, 400 volt, shunt-wound generators. The current is used for driving ten 25 Kw. series-wound motors, each connected to an 18-inch centrifugal pump.

The working of the dock is done from two central positions or valve houses, one on each wall, where are grouped all the levers for opening and closing the different valves. Each valve house is in direct communication with the engine room, so that the man in charge can manipulate everything for maneuvering the dock without quitting his station.

When it became necessary to clean the pontoons, doubt was expressed concerning the structural strength; for, owing to the fact that when the pontoons were uncoupled there was no way of pumping them out, it would be necessary to raise them full of water. It was decided, however, to undertake the work, the intention being to knock out some of the rivets of the raised pontoons when they were above the water and thus allow the confined water to drain off. The end pontoons were uncoupled from the side walls and the rest of the dock lowered to take them. The operation of raising began. Then it was that the rupture of the dock took place. The strain was so great that the side walls parted in way of a gangway in the manner shown in the accompanying sketch, which also illustrates the method of patching and stiffening.



VIEWS SHOWING THE RUPTURE, METHOD OF REPAIRING, AND THE CONSTRUCTION OF SIDE WALL OF HAVANA DOCK.

This was a very serious accident, especially in view of the fact that Pensacola was the nearest port where such an extensive repair job could be undertaken. The Navy Department decided that the two parts should be towed to the navy yard at Pensacola, and accordingly contracted with the Boston Towboat Company for that work. Under the direction of Assistant Naval Constructor Du Bose, the tug *Underwriter* and steamer

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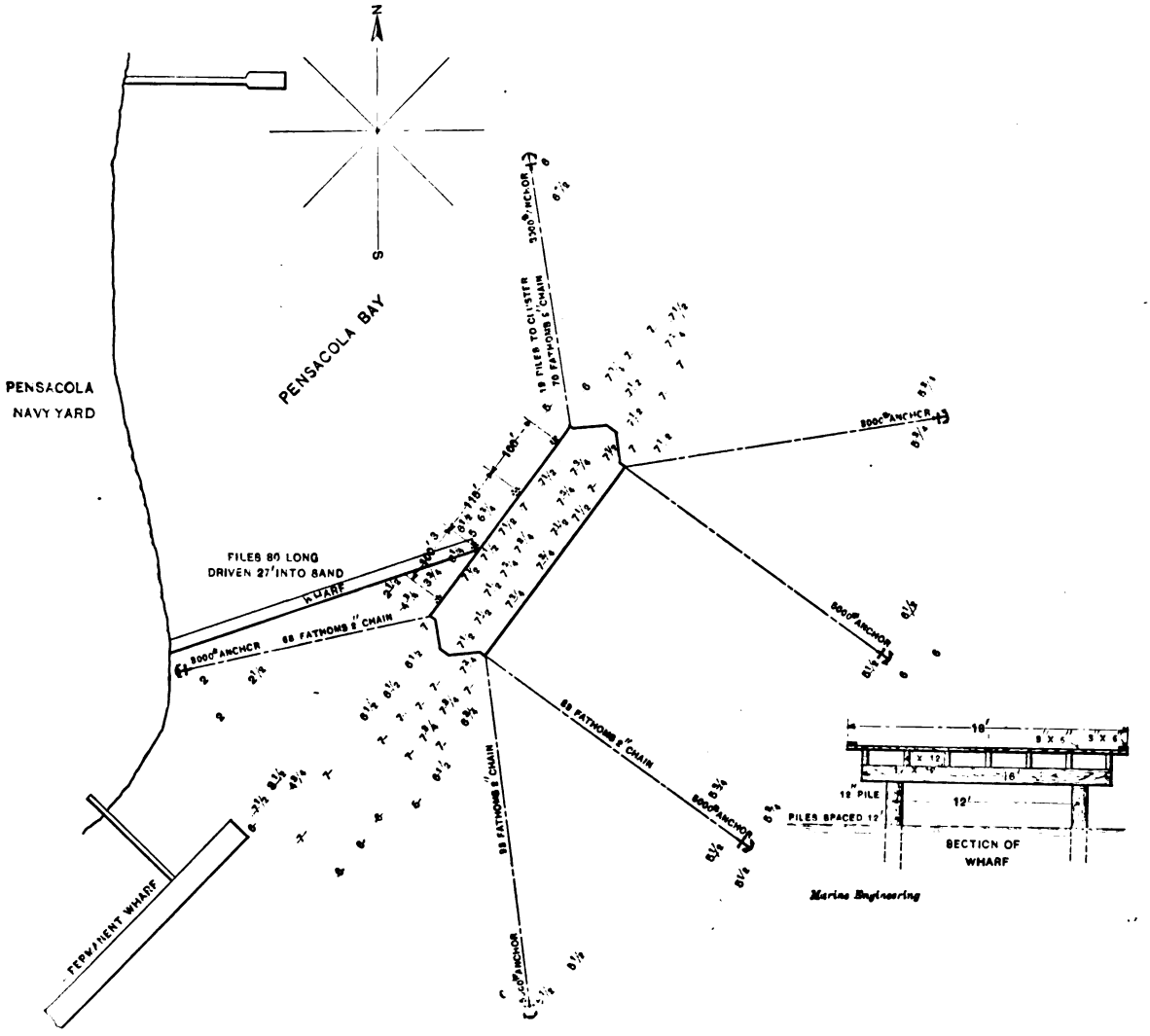
Orion, of the towboat company, brought the two parts across the gulf in November, 1902, and anchored them off the yard with only the loss of one of the small end caissons.

In January of this year the repair was started. The top plates of the side walls had parted across and, sheared the rivets, and the sides had ruptured in the same way, but on the under side the plates were crumpled up like paper. To perfect the repairs the two broken ends were brought together and patches put on as shown. The navy yard had at this time not taken on its present boom, and the stock of plates was low, nevertheless a strong job was made. At the same time all parts of the dock were overhauled, machinery taken down and set up, new chain shackles made, and the dock painted. It was then towed out into seven fathoms of water and moored by six 2-inch chains made fast to a corresponding number of anchors ranging from 3,000 to 5,000 pounds in weight, with the flukes of the inshore anchors further secured by having piles driven on the inside. Along the inshore side of the dock there are four nests of 80-foot piles, one nest at each end and one opposite each gangway. At the two latter points the dock is further secured to the piles by a chain and shackle. All of these precautions are necessary owing to the strong winds that sometimes blow in from the gulf, and the very strong tide running in and out. A wharf was built from the shore out to the dock, and a gangway board runs from the outer end of the pier to the opening in the dock.

The first trial of the rebuilt structure was made on September 5, when the Gulf Transportation Company's cargo steamer *August Belmont*, of about 4,000 tons displacement light, was successfully docked and painted. The accompanying photograph shows the *Belmont* in the dock. Another is a deck view of the steamer, from which the closely-spaced hatches and cargo derricks on either side are most conspicuous. The *Belmont* is a large steamer of the latest type, built at the yard of Swan and Hunter. She is employed as a collier between Pensacola, Fla., and Tampico, Mexico. At the time of the docking she drew 14 feet aft and 6 feet 3 inches forward.



LOCATION AND METHOD OF ANCHORING THE FLOATING DRY-DOCK AT PENSACOLA NAVY YARD.

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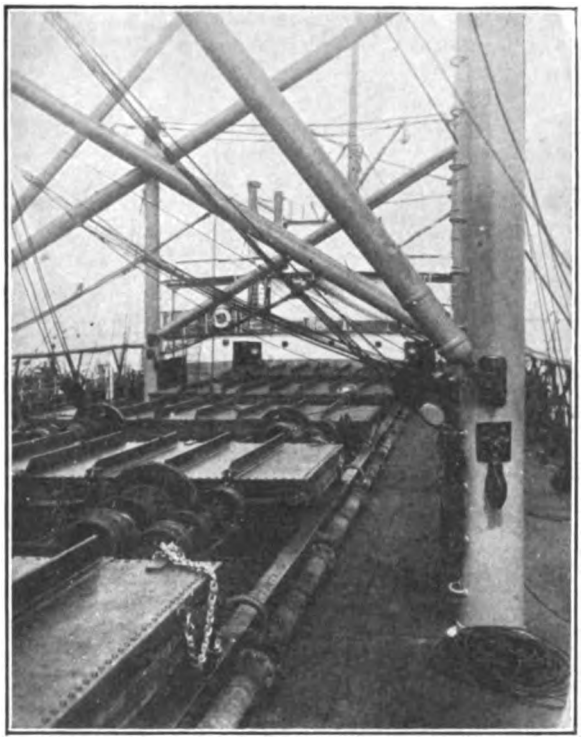
Captain F. W. Dickens, commandant of the eighth naval district, which embraces Pensacola, is endeavoring to have the Pensacola navy yard thoroughly equipped with modern machinery and buildings. Besides the 10,000-ton dock, there is a small one capable of docking a ship of 6,000 tons. The harbor is an ideal place for a naval station, with deep water and plenty of room for anchoring all the vessels of our Navy. Only until recent years has the government property been improved.



CARGO DERRICKS AND HATCHES ON THE AUGUST BELMONT.

New System of Water-Tight Bulkhead Doors.

The Hamburg-American line is fitting on the bulkheads of several of its vessels the patent Stone-Lloyd system of hydraulicly-operated doors. The steamship *Deutschland,* which sailed from this port recently, has all of the twenty-eight bulkhead doors below the water line equipped with this system. The doors may all be closed or opened from the bridge, and each individual door may be closed separately by hand levers on either side of the bulkhead. Another valuable feature is that should the compartment near a water-tight door become filled with water, that door is automatically closed by a releasing device operated by a float placed in a tank open to the bilge.

The doors are operated by hydraulic power, which is supplied by a duplex pump and a pair of steam accumulators, giving a working pressure of 700 pounds per square inch throughout the system. The fluid is a mixture of water and glycerine, which fills a pressure main leading from the bridge to each of the doors. There is also a drain or a return pipe led to each door, and across these two pipes each of the cylinders operating the doors is connected. The operating device on the bridge is a very simple one; but before the doors can be closed, alarm bells are rung throughout the ship to fifteen seconds to warn all persons of the intended closing of the doors. The mechanism is quite simple and consists of an hydraulic cylinder on whose ram a ratchet is cut. This ratchet engages a pinion, which in turn, through another pinion, drives a ratchet affixed to the bulkhead door. The pressure admitted above the ram closes the door, and similarly, if admitted below the ram, raises the door. The controlling valve is operated by pressure in the mains, regulated from the pilot house, and admits the fluid either under or above the ram.

The system has this special and most valuable feature, which is that, if the doors are closed from the bridge, any individual door may be opened from either side of the bulkhead, thus providing a means of escape to any of the crew who might be imprisoned behind the door; yet the device is so arranged that this door will automatically close itself again. The power for closing the door is sufficient to cut through a pile of coal, should the doorway be choked up with fuel. As it closes it is forced hard against the bulkhead by wedges in the door rim, and is thus made water-tight. From the inventor of this system, Mr. Ralston, a further description is expected.

NAME—August Belmont. NATIONALITY—British. TYPE—Cargo steamer.
LAUNCHED—1902. BUILDER—Swan and Hunter. OWNER—Gulf Transportation Co.

Length over all	388 ft. 0 ins.	**Propeller:** Number of blades	4
" between perps	372 " 0 "	Diameter	17 ft. 6 ins.
Breadth	50 " 6 "	Pitch	18 " 3 "
Depth of hold to upper deck	30 " 6 "	Area	98 sq. ft.
Draft, load	24 " 0 "	**Boilers**	3 single-end Scotch
Displacement, load	10,810 tons	Diameter	15 ft. 7 1-2 ins.
Dead-weight carrying capacity	6,900 "	Length	10 " 0 "
Block coef	.72	Steam pressure	185 lbs.
Number of cargo booms	16	Tubes, diam	3 1-4 ins.
Engine: Type	3-cylinder, triple	Furnaces	3 each
Cylinder diams	26, 43, 72 ins.	H. S.	7,800 sq. ft.
Stroke	48 "	G. S.	240 " "
Shafting diam	14 3-4 ins.	H. S. + G. S	32.5
I. H. P	about 2,000	H. S. + I. H. P	3.9
Cooling surface	3,000 sq. ft.	I. H. P. + G. S	8.3
Air pump	direct-connected, 24 ins.	Draft	closed stokehold

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STARTING LARGE GAS ENGINES.

BY E. W. ROBERTS, M.E.

The manipulation of a small gasoline marine engine is a comparatively simple matter and it requires no great manual effort to turn the engine over until it takes up its cycle. In large engines, however, it requires more than an ordinary man's strength at the starting crank to turn them over with sufficient rapidity for them to take up the cycle. Quite a number of different schemes have been used in the past in order to make it easy to start large engines. Among these may be mentioned a set of reducing gears with a ratchet which releases as soon as the engine gets its impulse. Another consists in allowing a portion of the explosive mixture to escape on the expansion stroke, and this pressure is stored in a tank to be used for giving the

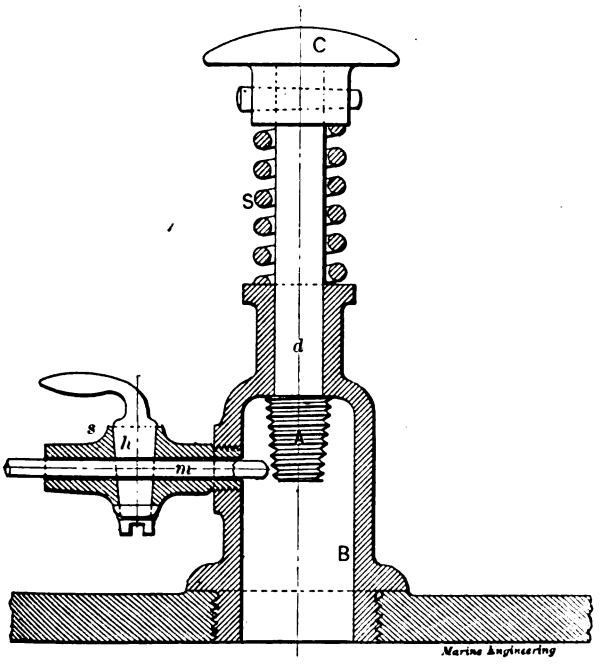

FIG. 1.

starting impulse to the piston the next time the engine is used, the engine running temporarily as an air engine. A still further development of this scheme is to install a small air compressor geared to the engine which is used to charge the tank, and the compressed air employed to start the engine as in the system just outlined.

In a very large engine where the horse power runs up into the hundreds, a small engine is connected with the large one to give it the starting effort through a system of gears. This engine, known technically as a "barring engine," can be readily started by hand, and when it gets up to speed it is thrown in connection with the large engine by means of a clutch, and the small engine used to start the large one. A still later development in starting mechanism is to charge the cylinder with a mixture of gasoline and air, to turn the engine over by means of a lever until the piston is just past dead center, and then to ignite the mixture by means of a detonating mechanism. In the modern multiple-cylinder engine, where the parts are accurately fitted and the pistons and piston rings given a good fit in the cylinder, a charge of gas and air will be held for a long time after stopping. This charge may be used for giving the initial impulse by first turning the engine over past the center and producing a spark at the igniter.

Quite a number of auxiliary devices have been developed from time to time, some of which are still in use by various makers. Among these are pumps for charging the engine with gas and air with which to give the starting impulse, and various forms of igniting mechanism in which the charge may be fired by an ordinary parlor match.

A good example of a detonating device is shown in Fig. 1. This starter consists of a steel body, *B*, which screws into the compression space of the engine. In the top of the engine is the plunger, *d*, with corrugated taper head, *A*, and at the outer end of the shank the cap *C*. The spring *S* keeps the plunger against the neck of the body on the inside, to which it is ground to form a tight joint. When about to start the engine an ordinary parlor match is inserted through the cock, and the plug *h* turned so as to grip it. About a teaspoonful or more of gasoline is put into a priming cup and a charge drawn in with the engine at the expansion stroke, and all the valves closed, air to fill the cylinder being drawn in through the priming cup. When the stroke is nearly or quite completed, the engine is reversed swiftly and turned as far as the compression and strength of the operator will allow. Just as the piston begins to stop, a blow of the hand on the cap *C* causes the plunger *A* to light the match and fire the charge. The resulting impulse is usually sufficient to carry the engine through three or four revolutions, which will allow it to take up its cycle. After the engine is started the plug *h* is turned and the explosion blows out the burnt match.

The use of the match for starting an engine is not, as a rule, necessary with an electric igniter, and it is a very simple matter to arrange the hammer break so that the spark can be produced by the blow of the hand; and with a jump-spark system a push button may be connected in a primary circuit of the coil, so that by pressing the button the circuit will be closed and a spark produced at the plug. A three- or four-cylinder engine fitted with jump-spark ignition is usually ready to start by simply closing the igniter switch and turning the spark advancer until a spark is produced in the cylinder which is nearest the top of the stroke. In general it may be said of this system of starting that the igniter switch should always be opened before closing the throttle, and the engine stopped in this way. There should always be a charge left in one of the cylinders to use for the next start.

In order to assist the operator it would be a good plan to mark the flywheel, say with a steel stamp, putting a *1* on the rim in line with the crank pin on the forward cylinder, and a *2* in line with the crank pin of the next cylinder aft, and so on for the other cylinders. This will indicate, by the number, which piston is nearest to the upper dead center and which cylinder should be used to start the engine. When ready to start, see that the flywheel is in a position such that one of the numbers indicates a certain piston to have

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just passed the upper dead center; then ignite the charge in that cylinder, having, of course, made all the usual preparations for starting. That cylinder should get an impulse which will carry the crank shaft round until one or more of the cylinders can take up the cycle.

If it is found that the cylinder will not hold a charge for any length of time, or the engine has been lying idle so long that the gasoline vapor has all escaped from the cylinders, it may be charged by means of a priming cup, of which an example is shown in Fig. 2. The priming cup allows the charge of gasoline to be measured, and is filled, according to the size of the engine, either once or twice in order to allow a certain amount of liquid gasoline to enter the cylinder for enriching the air in order to make an explosive charge. The amount of gasoline to be used for priming will have to be found by practice, and it should be remembered that in warm weather, or when the engine is hot, less gasoline is required than in winter when the engine is cold. The reader should remember that with a cold engine, only the lighter portions of the gasoline are likely to evaporate, the balance being blown out from the exhaust by the first explosion. The proportion which is evaporated increases with the temperature of the engine; and when the engine has just been shut down and is quite warm, perhaps all of the priming charge will be evaporated. In a two-cycle engine, quite frequently rocking the flywheel back and forth with the piston near the bottom of the stroke will serve to pump a charge of gasoline and air into the cylinder from the vaporizer; and then by throwing the wheel backward until the piston is near the top of the stroke, and snapping the igniter, the engine will receive a starting impulse.

Quite a number of marine engines have been fitted with a small air pump operated by a worm and screw from the propeller shaft, and an air pressure between 60 and 100 pounds is raised in the reservoir. This tank is connected, through a quick-opening valve, to the compression space of the cylinders. The engine is started by turning it over until one of the pistons has just passed the top of the stroke, when the valve is opened sharply and the pressure of the air starts the engine. The flywheel or crank shaft must be watched closely and the air shut off before the stroke is quite completed, so it will not retard the piston on the return stroke. Usually one impulse or "kick" is sufficient to start almost any engine; and as the impulse is in proportion to the piston area, the system works very nicely, irrespective of the size of the engine, so long as the air tank is of sufficient capacity. The writer believes that the capacity of the air tank should be at least ten times the piston displacement of the engine.

Recent correspondence on this subject with a large number of manufacturers of marine engines shows that the latest practice is tending toward the use of the igniter for starting. In a few of the very large marine engines a charging pump for filling one or more of the cylinders with a mixture of gasoline and air is used to supplement the igniter. In starting an engine by means of a charging pump, the pump is arranged to draw air through the vaporizer, or else is charged with a certain amount of liquid gasoline and air, and gasoline vapor pumped into the cylinder with the crank pin in that cylinder just past the upper dead center. So soon as the pressure is sufficient to start the flywheel the charge is ignited and the ensuing explosion gets the engine under way. The reader should note that the starting of the gas engine requires a little practice, and that there is a knack in it, just as with a great many other things in handling machinery.

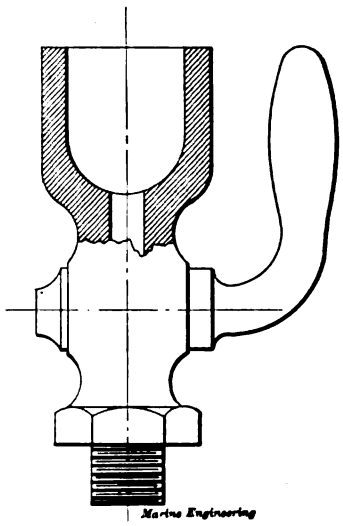

FIG. 2.

Engines of the Italian Cargo Steamer Selene.

From a correspondent in Italy the following description and illustration is received of the engines of the new cargo steamer *Selene*, built at the yard of the Società Cantiere Liguri Auconitain. She is built under the rules of the Italian Register and also Lloyd's, and is a sister ship to the *Regina Elena*, launched three years ago. The main engine is of the usual triple-expansion type, working on three cranks. The cylinders are of close-grained cast iron and not fitted with liners, therefore without steam jackets. Steam enters the piston valve high-pressure cylinder on the front of engine, and is carried by a copper receiver from the back of the valve to the intermediate valve; a second receiver on the front of engine finally carries the steam to the low-pressure valve. The intermediate and low-pressure cylinders have slide valves fitted with balanced pistons, and all valves are worked from Stephenson double-bar links. All cylinders and valves are thoroughly drained.

The cylinders are supported by six front forged-steel columns trussed by forged-steel stays, and by three back Y columns of cast iron. As seen in the illustration, the engine is most accessible, and presents a light but strong appearance.

The forged-steel crosshead is of the slipper type, with both go-ahead and astern surfaces babbitted. The connecting rods are forked at the upper ends for spanning the crosshead. The brasses are accurately fitted at either end and lined with white metal. The eccentrics are cast iron, made in two parts, and are babbitted on each side for the flanges of the eccentric straps, which latter are of cast iron, in two parts, and lined with white metal. The valve stems and eccentric rods are of high-grade forgings. The crank shaft is of the built-up type and in one section. As will be noted, the condenser

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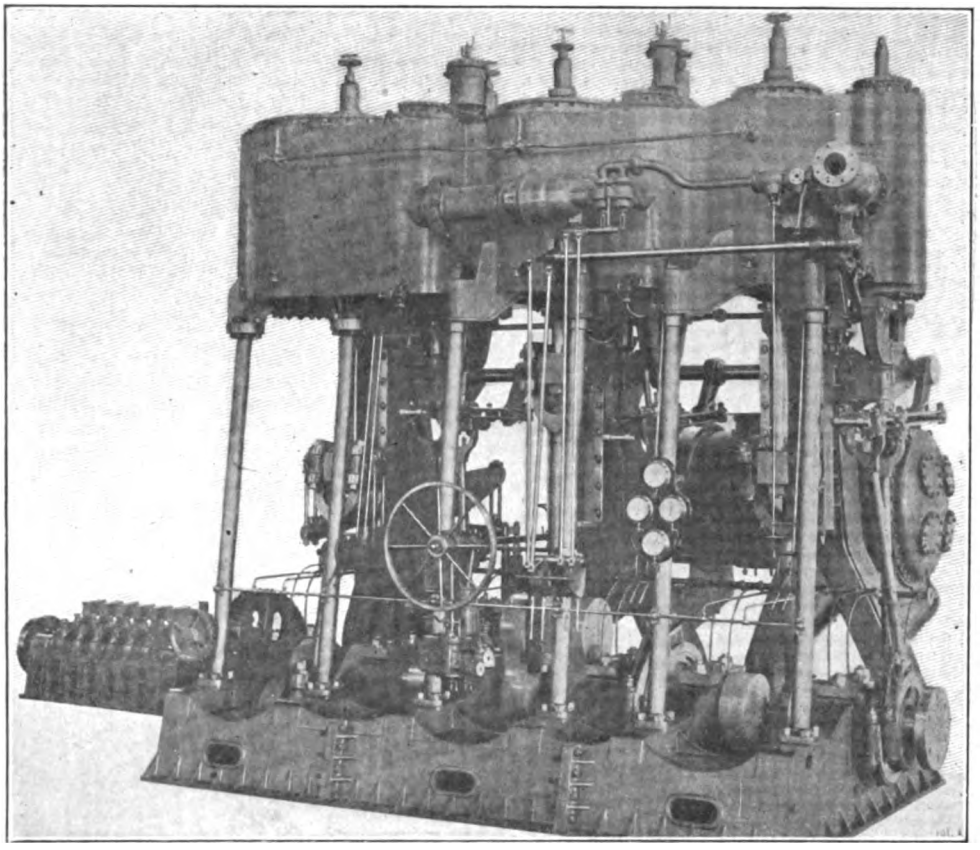
shell is constructed of steel plates, cylindrical in form, and supported on brackets on the back of the high and intermediate columns. Water is supplied by a centrifugal pump, and a vacuum is effected by a direct-acting air pump worked from the low-pressure crosshead. The bed plate is of box pattern, in three sections, bolted securely together. Reversing is accomplished by a vertical steam engine placed on the front intermediate column, which drives a cross horizontal shaft turning the reversing shaft at the back of the engine. The screw propeller is entirely of cast steel, with four right-hand blades. A complete system of both automatic and sight-feed lubricators is installed.



TRIPLE-EXPANSION ENGINE OF ITALIAN CARGO STEAMER SELENE.

NAME—Selene. NATIONALITY—Italian. TYPE—Cargo boat.

LAUNCHED—July 20, 1903. BUILDER—Società Cantieri Liguri Auconitain. OWNER—Raggio and Sons.

Length over all	352 ft.
" between perps	335 "
Extreme breadth	44 1-2 "
Depth	29 ft. 7 ins.
Draft, loaded	24 " 7 "
Displacement, loaded	8,500 tons
Hatchways, number	4
Speed, load draft	about 12 knots
Engine: Number	1
Type	three-cylinder, triple-expansion
Cylinder diameters	24 7-16, 40, 65 ins.
Piston, stroke	47 1-4 "
Valves, "	7 ins.
Revolutions, designed	70
Condensing surface	2,260 sq ft.
Direct air pump, diameter	20 7 8 ins.
Stroke	23 5-8 "
Propeller, diameter	16 ft. 4 7-8 "
Pitch	16 " 4 7-8 "
Blades number	4
Boilers: Number	2 single-end Scotch
Diameter	15 ft. 10 3-4 ins.
Length	10 " 0 "
Furnaces:	4 each
Inside diameter	39 5-8 ins.
Grate surface	172 sq. ft.
Heating surface	4,956 " "
H. S. ÷ G. S	28.8
Pounds of coal per I. H. P. per hour for sister ship Regina, Elena	1.55

Steam is supplied by two Scotch single-end boilers carrying a steam pressure of 190 pounds per square inch. Both engine and boiler rooms are fitted most completely with auxiliaries, and the machinery is expected to drive the steamer at a speed of about 12 knots.

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ELEVENTH ANNUAL SESSION OF THE MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The eleventh annual session of the Society of Naval Architects and Marine Engineers was held in the rooms of the American Society of Mechanical Engineers, 12 West Thirty-first street, New York, N. Y., on the 19th and 20th of November. The meeting was called to order on the morning of the 19th by President Griscom. The first business taken up was the secretary's report, which was read and accepted. The report shows that there are in all 844 members; that the balance on hand November 17 was $3,648.64; that the resources amount to $20,971; and that there are no liabilities. The council submitted the following recommendations for membership, the names were read by the secretary, and the applicants were elected:

Members, 12.—Edward P. Bates, manufacturer and contractor, steam heating and ventilating apparatus, 228 West Water street, Syracuse, N. Y.; Henry Edgeworth Frick, assistant superintendent of hull construction, marine department, Maryland Steel Company, Sparrow's Point, Md.; Robert Haig, surveyor to Lloyd's Register of Shipping, 846 North 63d street, Philadelphia, Pa.; James R. Hampton, superintending engineer, Townsend-Downey Shipbuilding Company, Shooter's Island, N. Y.; James Henry Mancoe, principal engineer surveyor for United States Lloyd's Register of Shipping, 15 Whitehall street, New York, N. Y.; Edward Lasius Peacock, marine engineer for Midvale Steel Company, Nicetown, Philadelphia, Pa.; George Stanbury, principal surveyor, United States Lloyd's Register of Shipping, 15 Whitehall street, New York, N. Y.; Carl Wilhelm Vollman, president Linde British Refrigeration Company of Canada, 301 St. James street, Montreal; William Carlile Wallace, marine consulting engineer, Messrs. John Brown & Co., Ltd., Sheffield, 116 East 17th street, New York, N. Y.; Henri Wilkinson, chief surveyor to the Bureau Veritas, 17 State street, New York, N. Y.; Louis L. Bernier, James H. Mull.

Promotion from Associate to Member, 7.—Ralph Ensworth Barry, Newport News Shipbuilding and Dry-Dock Company, 111 33d street, Newport News, Va.; David W. Dickie, draughtsman in charge, office of superintending constructor, Moran Brothers' Company, Seattle, Wash.; Thomas Gaines Roberts, assistant naval constructor, Navy Yard, Mare Island, Cal.; Charles H. Thayer, draughtsman, Newport News Shipbuilding and Dry-Dock Company, Newport News, Va.; Johan H. Norman, Cramp's Shipyard, Philadelphia, Pa.; Archibald M. Main, Stuart F. Smith.

Associates, 18.—Karl Eimar Walfrid Alland, draughtsman at New York Shipbuilding Company, 521 Penn street, Camden, N. J.; William H. Balls, draughtsman, Construction and Repair Department, Navy Yard, Philadelphia, Pa.; George Kearney Bradfield, sales and technical department of Vacuum Oil Company, 29 Broadway, New York, N. Y.; Edwin F. Church, Jr., instructor in marine engineering and naval architecture, Lehigh University, Bethlehem, Pa.; James Frederick Clegg, leading ship draughtsman, Crescent Shipyard, Elizabethport, N. J.; Leroy Eugene Caverly, hull draughtsman, superintendent's office, Union Iron Works, San Francisco, Cal.; John Charles Craven, hull draughtsman, Crescent Shipyard, Elizabethport, N. J.; William Leggett Gilleudeu, president and general manager, Old Dominion Steamship Company, New York, N. Y.; Gustaf M. Lagergren, hull draughtsman, New York Shipbuilding Company, Camden, N. J.; George W. Neff, eastern manager of Bierce and Smith Vaile Company, Dayton, O., 141 Broadway, New York, N. Y.; William Hackett Phillips, manager marine department, F. H. Devoe and C. T. Reynolds Company, New York, N. Y.; Herbert Bernard Saunders, marine surveyor and appraiser, 15 Whitehall street, New York, N. Y.; Edward Murray Speakman, engine draughtsman, Fairfield Shipbuilding and Engineering Company, Glasgow, Scotland; Anson Phelps Stokes, 100 William street New York, N. Y.; George Andrew White, assistant to general manager, Hudson River Day Line, Desbrosses street pier, New York, N. Y.; Llewellyn Williams, chief engineer and acting manager, Linde Refrigerating Company, 45 Broadway, New York, N. Y.; Paul Gerhard L. Hilken, Eastern Shipbuilding Company, New London, Conn., Alexander G. Boutakoff.

Promotion from Junior to Member, 2.—Charles Barnard Page, marine and mechanical engineer, Baltimore, Md.; John Howland Gardner, assistant superintendent marine construction, New York and New Haven Railroad Company, Newport, R. I.

Promotion from Junior Membership to Associate, 1—Edward G. Tuck, foreman in charge of mould loft and template work, Eastern Shipbuilding Co., Groton, Conn.

Juniors, 15.—Oliver Marcy Davis, engineering assistant to superintendent, Semet and Solvay Company, Ensley, Ala.; Lewis Hobart Kenney, draughtsman, office of Inspector of Machinery, U. S. N., William Cramp & Son, S. and E. B. Company, Philadelphia, Pa.; William John Norton, fitter, Chicago Shipbuilding Company, Chicago, Ill.; Horace Albert Staples, second assistant engineer, S. S. Hinon, Clyde Steamship Company; Ernst J. Thunberg, draughtsman, engineering department, Bath Iron Works, Bath, Me.; James Meriwether Winston, hull draughtsman, J. I. Thornycroft and Company, Chiswick, London; Martin C. Erismann, chief draughtsman, Marine Construction and Dry-Dock Company, Staten Island, N. Y.; Edwin A. Stevens, Jr., Daniel Bailey, Albert E. Ewen, Robert C. Simpson, William Stanke, Charles C. Moss, Robert W. Bailey, Arthur V. Curtis.

At the recommendation of the council the following officers were elected:

President, Francis T. Bowles.

Past President and Associate Member of Council, Clement A. Griscom.

Vice-Presidents, Charles H. Cramp, Frank L. Fernald, U. S. N., Philip Hichborn, U. S. N., Charles H. Loring, U. S. N., George W. Melville, U. S. N., George W. Quintard, Edwin A. Stevens, Stevenson Taylor, Robley D. Evans, U. S. N., W. L. Capps, U. S. N., Charles W. Rea, U. S. N., Frank E. Kirby.

Members and Associate Members of Council, W. Irving Babcock, James E. Denton, George W. Dickie, William F. Durand, Nat. G. Herreshoff, Ira N. Hollis, William H. Jaques, John C. Kafer, U. S. N., Frank B. King, Walter M. McFarland, Jacob W. Miller, Albert P. Niblack, U. S. N., Lewis Nixon, Cecil H. Peabody, Walter A. Post, Harrington Putnam, Horace See, E. Platt Stratton, David W. Taylor, U. S. N., George E. Weed, J. H. Linnard, U. S. N., W. D. Forbes, W. H. Brownson, U. S. N., C. R. Hanscom.

Executive Committee, Lewis Nixon, Stevenson Taylor, Edwin A. Stevens, Harrington Putnam, W. L. Capps, U. S. N., Francis T. Bowles, *ex-officio*, W. J. Baxter, U. S. N., *ex-officio*.

Secretary-Treasurer, W. J. Baxter.

President Bowles took the chair and opened the technical session.

The Chairman: Gentlemen, I thank you heartily for the honor which you have done me. I shall have pride and pleasure in acting as your president, and I may say that I feel especially the honor of my election as the successor to Mr. Griscom, to whom this society is so deeply indebted. It has been customary for the incoming president to make an address to the society, generally directed to the prospects of the arts which we represent. I am going to suggest to you that this ad-

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dress be delivered to you by the retiring president, so that next year, when we meet again, I hope to have something pleasant to say to you. The only agreeable thing about the present situation of our art is that the condition of commercial shipbuilding is so bad that it cannot get worse.

PROGRESSIVE TRIALS OF FERRYBOAT BREMEN.

BY COL. EDWIN A. STEVENS, VICE-PRESIDENT.

ABSTRACT.

The ferryboat *Bremen* was given extensive trial in 1894, and in September, this year, when she was fitted with new propellers and her bottom thoroughly cleaned, another series of progressive trials was run. The data, which were most carefully observed and recorded, of the two series are analyzed according to Taylor's system of analysis. In the absence of single-screw trials, to use this analysis, assumptions were made for the wake factor and the propeller constant, and then the true slip of the forward screw and the efficiencies of the thrusts of both wheels were calculated. The other points determined were the skin friction and wake-making resistance, and the race augmentation. From these results the following curves were compiled for both series of trials, viz.: (1) The curves of slip and revolutions; (2) speed and revolution; (3) M.E.P. and revolutions; (4) I.H.P. and speed; (5) thrust at bow and stern; (6) the division of power and (7) wake at bow, the last three plotted to the scale of knots. A comparison is made between the trials of the *Bergen, Cincinnati,* and the *Bremen.*

The author states that although he is not yet prepared to accept the calculation as final, the data are presented to illustrate the method in which this analysis may be carried out. He concludes, however, that the wake of the forward screw has a definite value, varying with the speed.

DISCUSSION.

COLONEL STEVENS: Before submitting the paper to discussion, I wish to say that subsequent calculations made since the writing of this paper would lead me to revise that expression, "race augment," as used in this paper. Race augment should be taken to mean the difference in the resistance of the vessel when towed, or when driven by her own screws, and should, therefore, include thrust reduction. In other words, I believe in this shape the thrust reduction is not in any way a negligible feature. I am not prepared to submit any very detailed figures on that point now, but as far as I have gone that seems to be the conclusion pointed out, and I had not the time in the preparation of this paper—you note that the date is very close, September 20, last—I have not had time to apply these calculations to other vessels.

PROFESSOR SADLER: I think the thanks of this institution should be given to Col. Stevens for adding a little light on this somewhat vexed problem of ferry propulsion. A few months ago I had occasion to go into the question of analysis of trial trip results on ferryboats with Col. Stevens, in connection with the New York ferries—the new Staten Island ferries—and one of the first things that we had to decide upon was the distribution of power between the bow and the stern screw. The first assumption that we made was, as in the paper, that the apparent slip and the true slip of the bow screw were the same. This is not necessarily the case, as we can see from the wake curve that Col. Stevens has plotted in this paper. There are two items that seem to me to have a very important bearing upon the slip of the bow screw, and upon its performance, and those are the position of the bow screw relative to the end of the ship, and the position of the bow wave, and it seems to me quite possible in certain circumstances we may get even a negative wake at the forward end of the ship.

It may be interesting to note, in connection with the shape of the wake curve that Col. Stevens has plotted, that by an independent method I got an approximation to the variation in the wake, and I think in my curve the numerical values were different from Col. Stevens'. The general character of the wake curve was the same, that is, it started to rise at the lower speeds, then remained either normal or very nearly constant, then rose again to the highest speeds, and showed a falling off at the end, I think showing that the character of the wake curve, as shown in the paper, is approximately correct, as near as I can make out.

Some criticism may be raised as to choosing a wake factor value of .12 for the after screw, that factor being obtained from the single-screw trials of similar vessels. There is no doubt that the race of that forward screw will somewhat affect the race at the after screw. It also tends to increase naturally the difference between the thrust and loss deductions of wake gain. But, on the whole, I think Col. Stevens is perfectly right in crediting all that loss to what he calls this "race augment or resistance," because the bow screw is the direct cause of that increase in resistance. When it is noticed, as in the paper, that the difference in efficiencies for two practically similar vessels varies as much as from ten to fifteen per cent., I think the need of careful analysis, such as we have in this paper, is immediately apparent.

PROFESSOR PEABODY: I hope Col. Stevens will find it possible to add an appendix, if necessary, or additional data which he says he now has in hand, and that it will give a material gain to the society, especially as adding to so important a piece of work as all such trials must be.

MR. NEWMAN: I would like to hear from Mr. Stevens as to what he thinks of the future development of the turbine in boats of this character. It looks to me as if it was particularly adapted to those purposes.

MR. TAYLOR: I was glad to hear Col. Stevens explain in this paper that the race augment, as used by him, was intended to include both the thrust reduction and the active resistance of the rise of the forward screw, because it seems to me that he assumes the efficiency of one, in other words that he assumes that the thrust reduction is neutralized by the gain from the wake, and as he has a wake of twelve per cent. he must necessarily have a thrust reduction of about twelve per cent. of the thrust of the rear screw. Even that, however, leaves a very large race augment to be accounted for. A race augment that he gives at eleven knots for the *Bergen* is 209 horse power, and referring to the curve of I. H. P. at eleven knots, it would seem that an increase from eleven to twelve knots requires somewheres in the neighborhood of 300 or perhaps a little over 300 horse power.

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I should say the rate of increase at eleven knots is a little over 300 horse power. In other words, it would seem as if the race augment were equivalent to holding back the ship from one-half to three-quarters of a knot in still water. It seems that Col. Stevens has run across a puzzle in these trials which is very apt to be the case in analysis trials. The trial in 1894 and the trial of 1903 practically differ only in the screws used. In the trial of 1894 the screw was a good deal smaller than the screw used in the trial of 1903, and referring to the curve of I. H. P. in speed at about eleven knots, the curve of 1894 crosses the curve of 1903 and proceeds to rise every mile very rapidly, the slip increasing very fast. Looking at that curve, and looking at the outlines of the propellers, the natural inference, of course, would be that the propeller of 1894 was too small, and that it showed signs of what since then we have learned to call cavitation. But when we look at the curves of the slip we see that the 1894 curve of slip is actually less than the 1903 curve of slip, until we reach a speed a little over eleven knots. The only reasonable accounting for this is that the pitch of the 1894 screw was too small as given—the pitch was not known. That is one of the puzzles we are very apt to run across in these experimental results, but there is a remarkable difference in the speed given by these two screws, and something we can scarcely account for on any present theory so far as I know of screw action.

MR. STEVENS: I would say, as to the wake values, there can be absolutely no question but that the wake for the forward screw will affect the value of the wake at the after screw. Professor Denton some years ago on investigation of these very trials—1894 trials of the *Bergen*—estimated that the wakes delivered by the forward screw would come to a rest if considered as a column of water projected into a large body of water, would come to a rest at a distance of about 50 feet aft the screw. In other words, the water 50 feet aft the screw would be very nearly in the condition as normal as at the stem, so that it would amount to deducting 50 feet in the length of the vessel as far as creating a wake is concerned. The effect of that seems to be very difficult to estimate. We have single screw trials of three vessels, the *Bergen*, the *Cincinnati*, and the *Edgewater*. The first two are about 200 feet in length, the *Edgewater* about 170. The breakwater efficiency of the boats is practically the same, and at the same time the wake works out very nearly the same in all three vessels. The maximum value, as I recall it now, is .125, and the minimum is .117. As to the *A* values, they will plot remarkably low. The lowest is .375 for the after screw, and for the *Froyd's* trial screw the value is somewheres over .70.

As to turbines, that matter has been pretty carefully considered. The difficulty lies in this, that the efficiency of propulsion seems to depend a great deal on the slip. Of course these boats all seem to improve where it is possible to give them a long trial. Inclination of the propeller shaft is impossible in this type. It restricts the diameter of the wheel unless excessive draft is taken, which involves an increase of wetted surface and other drawbacks, and also a loss of stability in the vessel itself, which becomes of importance. In considering the stability of a ferryboat, you must remember it is not any question of upsetting or a dangerous heel, and there is a crowding on these boats that would not be permitted on any other boats; that means an incline or tip of about fifteen degrees. With a ferryboat crowded with a lot of passengers that heel creates a panic. Therefore the stability has to be very carefully considered.

With the turbine, it seems to be that not enough is known as to the proper propellers to use to settle the question. The available data are not of the most satisfactory character as to that question, and at present it seems to involve the use of small propellers of very fine pitch, running with considerable slip, and that, in anyone's judgment who has considered it with relation to the ferryboat problem, has been enough to condemn the type. There is another question here which makes the turbine particularly ill adapted to ferry service, and that is the requirement of running in both directions. It means, in order to secure the efficiency, a practical duplication of the driver, so that the saving in weight is almost done away with.

As to Constructor Taylor's remark, it is perfectly apparent to anyone familiar with the system for the analysis of trial results, that it is impossible with complications introduced by the forward screw, to get the actual hull resistance. You have to estimate that for the purpose of the test. The object of it is to divide the power delivered to the shaft between the screws and to determine as far as possible the efficiency of each of those screws. In other words, determining how the thrust is exerted, as bearing out, to a certain extent, the idea that I have just mentioned, that the decrease in slip is to avoid the injurious action of the race augment proper—that is, the resistance due to the race from the forward screw. That race augment is, of course, due to the water thrown back by the forward screw. Now, the two vessels which have shown the highest propulsive efficiency of which I have data, have been the *Newark*, of the Pennsylvania Railroad, and the *Edgewater*, of the Fort Lee ferry. On these two boats, from different causes, the forward screw is worked at a disadvantage. Both boats have rounded backs to the blades—in other words, the blades are shaped like the blades to an ordinary vessel. In the *Newark* the blade is of a modified type with general lift of a rather large surface, and the generatrix is inclined aft and curved. I have no exact data as to the differences between the two screws. I have just got the pitch given generally. I will give the effect of that afterward. As far as I have been able to analyze in the trials, using practically the same system as Lamont's, but with probably more assumptions, and, therefore, with less accuracy than is possible in this case, the *Newark* showed unquestionably a high propulsive efficiency. In the case of the *Edgewater*, by one of those contrary circumstances which happen, the pitch of the forward screws turned out to be less than the pitch of the after screws, the difference being about two inches in ten feet of pitch. In the *Edgewater* the difference between the single-screw trials and the two-screw trials is comparatively small, and plotting out (if we take that difference, merely considering that difference between the two trials) the space between the two curves, and attempt to account for that, we have two items to charge to it: one is the propeller losses due to the forward screw—the ordinary propeller losses—and the other this

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race augment. Therefore, applying the same system used herein, with the *A* value determined, the *W* value (the value of the wake for the single-screw aft) is determined by the trials, and the fair value of *A* can be determined from the forward screw. That seems to work out between seven- and eight-tenths of the value of the aft. Of course, it is possible in the forward screw single trial to get the *A.W.* diagram. You can't get the intersectional curves, you cannot get loops for them, but the limits between which you can work with all the assumptions I have been enabled to make, seems to indicate a value somewhere between seven- and eight-tenths with the rounded backs of the other one that I have assumed in the trials of the *Edgewater;* in that case, as I say, it was a mere strip of the space under the I. H. P. curve. The result seems to point to the fact, as Prof. Sadler would say, the position of the screw in relation to—well, we will call it to the shape of the bow—practically is of very great importance. That is to say, those boats that seem to have the screw forced away from the body of the vessel, taking into consideration the other elements which would affect their efficiency, seem to show the best results; that is to say, as the screw gets nearer the end of the water line it seems somehow or other to offer less impediment to the vessel's progress.

MR. WHEELER: I would like to ask the Colonel if the correctness of the steam gauges and the vacuum gauges were verified. I noticed in the trial of the *Bremen* that the vacuum ranged very high, in over half the trial 28 inches, while in some cases it is 28.8. It occurs to me it requires a little correction there.

MR. STEVENS: The vacuum gauges had been verified about six weeks before the trial, but the springs on the indicators were tested and gave a little over an inch less of the vacuum than that shown.

MR. WHEELER: I think that is doing very well, to have only one inch less in the cylinders.

THE CHAIRMAN: Gentlemen, if no further remarks, the Chair observes from the discussion that, while this discussion seems to deepen the mystery that surrounds the action of screw propellers, it is undoubtedly of value in the way of engineering data as the continuation of the trials of ferryboats which Col. Stevens' liberality and great interest has laid before us. The Chair hopes that it will fall to the lot of some member of this society to ultimately investigate thoroughly the action of screw propellers. The Chair feels confident that this will be the case.

We will now proceed to the next paper. The Isthmian Canal seems to be settled, and so the second paper has been withdrawn.

NOTES ON THE ARRANGEMENT AND CONSTRUCTION OF STEAM PIPES AND THEIR CONNECTIONS.

BY ROBERT C. MONTEAGLE, MEMBER.

ABSTRACT.

As stated by the author, the principal object of the paper is, first, to point out and emphasize some of the causes of failure of steam pipes; and, second, to describe some points to be observed in design and material. The causes of failure in steam piping are, first, faulty design; second, bad workmanship; and, third, defective material. Under the first head the employment of copper for high pressures is considered to be a mistake, as its elastic limit is only about 5,400 pounds per square inch; steel should be used, as its elastic limit is over 30,000 pounds. Copper is always more or less injured in the neighborhood of brazing, and all large-sized copper pipes are made up sectionally. Illustrations are given of some common methods employed for taking up expansion, which are of most faulty design. During the manufacture and erection of pipe sufficient care is not observed to insure against defective material and workmanship, and the author strongly urges the general adoption of severe tests for specimen pieces of all piping. This test should be repeated, as often latent defects do not develop until pressure has been applied two or three times.

An illustration is given of an expansion joint properly designed to take care of all expansion and at the same time not subject the piping to any undue strains or twists. Then are given specifications for copper, seamless steel, and lap-welded steel steam pipes laid down by the Bureau of Steam Engineering, covering the inspection and testing of all classes of steam piping.

DISCUSSION.

MR. FORBES: Mr. Chairman, a year ago I wrote a paper which I intended to lay before this association, but after having written it and putting it aside, I read it over and it put me in mind of the pudding that we used to have at school—too much dough and not enough plums—so I threw it away and saved the society the agony. But this paper gives me an opportunity to offer the plums, if you may so call them, in a few words. I had hoped that I was the inventor of the idea which I first wished to suggest, but afterwards, meeting Mr. Meyers Corriel, I found I was not the originator at all, but that Mr. Bellville was the originator of the idea, that he believed that his system, which I thought was mine, coupled with a certain kind of fish oil, produced a tight joint in a fire. And that, gentlemen, is simply this, and I found it accidentally, that if you will take the ordinary American fittings, say of an inch to two inches of 11 1-2 threads, and take your flange as 11 threads, you can make a perfectly tight joint with almost no difficulty whatever. That is Mr. Bellville's idea. I think if you will adopt that you will in many cases overcome difficulties and save yourself trouble. That is for the thread. Now, when you come to the flanges, I have found great difficulty under high pressures of keeping the flanges from blowing out, and I adopted some years ago a method which is absolutely satisfactory. All I did was to dish those flanges—that is to say, to make them so that when the packing was drawn together it was drawn together more closely on the outside of the flange than on the inner side. The result was that you had a wedge-shaped form into which the packing was driven by the pressure, and it kept it perfectly tight.

Of course, there are a great many jim-cracks we get up. One of them I have here, which I want to show you, and I want to say there is no patent on this, and if anyone wishes to look into it he is most welcome. I found that in ship work, in piping, there was always some sort of angle or twist that they did not make any fitting for, so I got up this little apparatus, and there again my pride had an awful fall, because I found a man

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had gotten up a better one long before me, but no one used it, but there it is. You have simply a straight run which can be used as a union, by just turning you have an elbow. Now, of course, you can get any position from the straight run with this joint pointing in any direction, until you have anything from a straight run to forty-five degrees. That has been very useful to me. The objection to it is, of course, you have a bolt through there which will gradually deteriorate, but the rival got over that by putting a union nut on the outside, which is very much better, but it isn't in the market and I don't think it can be obtained.

Mr. Lovekin: It has been my pleasure during the last four years to have done a great amount of experimenting with, inventing, and perfecting a system of pipe expanding and flanging machinery and tools, which are about ready to be placed on the market. These machines and tools embody all sizes and classes of expanding, flaring, and beading tools, also tube cutters. We are making at present a machine which will expand and bead or flange piping 24 inches in diameter 20 feet long. This machine weighs 20 tons, and the tools alone will weigh over one ton. I have successfully demonstrated the practicability of all these machines and tools with tests which I am about to submit to you given by me in a lecture before the Franklin Institute on this subject October 20, 1903. I gave a full description of the machines and tools in actual operation, together with numerous samples of work exhibited. The interest shown at this meeting was such that I made further tests from samples of 2 1-2-inch seamless-drawn tubing with United States Navy standard steel flanges. I had intended using the regular dudgeon-pipe expander on two of these samples so as to test the difference between the joint made with the old-style expander and those made with my new types. Owing to the short space of time, however, I was compelled to give up the idea, and made all joints with my tools.

I believe these joints will, in every case, stand the same test as any welded steel flange, inasmuch as the shearing value of the grooves can be made such as to cause failure of the pipe itself before leaking. I can also state positively that, with my machine and tools, we can make a joint that will stand fully double the test pressure of other joints made with any known expander. This is due to the construction of the tool, it having an immense advantage in the feeding mechanism which consists of a hand wheel the inside of which forms a nut which comes in contact with a threaded pin passing through the mandril. Thus we have the circumference of hand wheel divided by the pitch of thread for power applied to advance mandril, minus friction. The mandril is freely revolving instead of a fixed mandril, thereby all torsional strains are removed. In my case outside are a couple of samples which I brought this morning from Philadelphia, and I have the subject matter here of several tests which I will be glad to read, and also give to the society, which verify Mr. Monteagle's statement very much.

Here follows a report made by the Quinby Engineering Company, Philadelphia, at their laboratory on November 9, on samples of pipe. The first one was a No. 10 B.W.G. 4-inch inside diameter steel tube expanded into cast-iron flanges on each end, 2 1-2 inches thick, each end being covered with cast-iron blank flanges of 6 inches held by four 1 3-4-inch bolts. A standard 1-8-inch gas-pipe connection was tapped into one end for applying hydrostatic pressure. At a pressure of 3,800 pounds per square inch the flange opened and packing blew out, showing that heavier bolts must be used.

The second test was made on a brazed copper pipe of 4-inches diameter and 5-32-inch thick, each end being hammered and brazed into composition flanges 1 5-8 inches thick, otherwise being the same as in test 1. The pipe burst at 1,900 pounds per square inch. At the brazing the elongation was 3-8 inch. The pipe also bulged near the flanges.

The third test was made on a solid copper pipe of same size as No. 2, the ends being flared 20 degrees, and each was expanded into three grooves 1-8 inch wide and about 1-64 inch deep in 2 1-2-inch cast-iron flanges; otherwise conditions were the same as previous. A slight elongation was noted up to a pressure of 3,400 pounds when the flanges slipped on the tube 5-16 inch with a jump shearing the ridges off. On applying pressure up to 400 pounds a second time, there was absolutely no leak. According to the United States Navy formula the comparative strength of brazed and non-brazed pipes is as 4.4 to 1. Other tests are reported on steel pipes, expanded and flanged in the machines designed by the speaker are given, and in conclusion he states as follows:

On previous tests that I made with brazed pipes and pipes not brazed, in every case where I could get a pull such as I did without any internal pressure by applying the hydraulic jack on the inside with a blank flange at the bottom, putting a plunger in so as to get an end pull, the brazed pipe was in every case about twenty per cent. weaker than the pipe simply expanded, and when it came to the bursting test the pipe not brazed was 4.4 times stronger than the brazed pipe.

Mr. Newman: Mr. Lovekin's experiment on the expanding machine is very interesting and shows practical skill in its development, but I think we should approach the use of an expanded tube in a steam pipe very cautiously for this reason: We can expand a tube into a flange for water, air, or low pressures, but a pipe under the pressure of steam or temperature where it expands and contracts, would tend to loosen the flange from the pipes. These tests, of course, are only tests under hydraulic pressure. If they were applied with steam I think perhaps the result would be that the flange would loosen constantly. I think we can't do better than to follow facts.

GASOLINE ENGINES FOR MARINE PROPULSION.

BY D. H. COX, MEMBER.

ABSTRACT.

This paper first deals in a most elemental style with the functions of gas engines, stating the method of starting and controlling the engine, describing the difference between the double and four-cycle type and other features. Then follows detailed description of two of the largest types of gas engines yet installed in boats, the *Standard* and the *Adios*, the two fast-speed

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launches which appeared this year. The general dimensions of both boats are given, and an extended description of the construction of the *Standard* follows. Designs of these and two other freak-type boats, and photographs taken of them at full speed, are presented. The author believes that from the success attained with many of these designs of small types the government would be warranted in getting out similar lines for torpedo boats.

DISCUSSION.

MR. COX: I might have stated a little more clearly that it is very difficult indeed to arrive at any conclusions whatsoever in the performance of launches when you only have the reading given by the manufacturer, because, for various reasons, some manufacturers underestimate and others overestimate the output of their engines of given size, and it is very difficult indeed in the small engines used, the expense hardly warrants taking indicators. You take, for instance, a 6-cylinder, 100-horse-power engine, although the cylinders are all alike, it would not by any means be safe to assume each cylinder was doing the same amount of work, and that by indicating one you could arrive at the total horse power by simply multiplying by the number of units, and unless some more reliable method, or more care is taken in the rating of engines, it is rather hard to arrive at any conclusions. Then, again, I would state that the speeds I have given, as mentioned in this paper, I don't wish in any sense to be responsible for, as I was not present at any of the trials, except possibly the Standard, which I can state from personal experience has run about the speed I have mentioned.

MR. SADLER: I would like to ask Mr. Cox as to the amount of gasoline used on the different types of engines. I think that information would be very valuable, and is very hard to get.

MR. COX: I would say I haven't had any opportunity to make any experiments of that sort, but I am convinced from inquiry among a number of people who would have no object to state anything that was not correct, that for a launch of a given horse power, and a given tank, a pint per horse power isn't very far off. But there are a good many reasons that affect that. Some makers have an arrangement by which they can draw the air supply from a heated source. That has a very considerable effect on the consumption for some reason. Of course in winter weather it is the practice of a great many manufacturers to draw the air supply from a heated source, but even in summer, when the temperature of the air is warm, some people further warm it by jackets around the pipe, and that has a considerable effect on the consumption of gasoline. And under those conditions, although you will not get as much horse power out of an engine, the consumption is less, but that has not been looked into as much as it should.

MR. STEVENS: I think that this paper is very timely just now, because we are at the beginning of a new era in launches. There is no question of that. Within the past two or three years there has been a very marked development in the use of the gasoline motor or the explosion motor. It has found its way into auxiliary yachts formerly sailing vessels; and also into the smaller types of fishing boats, even the oyster skiffs, and small surface boats of the fishermen, and also small boats used in the commercial service. Just now we are tending toward a development on the lines of the French type. I think it should be stated here very plainly that the launch is practically an American institution in its use. The furthest back I can trace the history of any launches is to the work of our esteemed member, Mr. Haswell, whom I think produced a steam launch in 1857, but the modern power launch, as it is called, is an American institution. It is more numerous in this country and more fully developed to-day. The first power launches we had was about twenty years ago when the naphtha launch, driven by a small steam engine using naphtha as fuel and using the vapor in the engines, came into use. Following that the explosive motor of the Daimler type came in about fifteen years ago, and while both the automobile and the launch came from a common source, our development of launches has preceded that of the automobile, for during this period of fifteen years they have produced in this country a very large number of launches, many of them very roughly built, not very refined engineering, the two-cycle in the smaller sizes, and the four in the larger, and these have gone into all sorts of boats and have given very excellent service, of course with some local defects. Within two or three years the French have pushed the launch question to a very high point of perfection as far as speed goes, but this work has been done by the French automobile makers and yachtsmen. They have used the light automobile engines for launches intended for speed, of very slight construction and design. There has been formed in France in the last few years the Helice Club, devoted exclusively to launch racing. In the past year there has been a great deal of work done with launches in France; there have been two races of 100 kilometers, endurance runs, and also a race from Paris to the sea. England has been behind us in the launch races. They have used for yacht tenders or similar boats the paraffin motors, distinctly inferior to the American gasoline motor as used here for years past, but in the last few years there has been a furore in England for the American type of gasoline motor, and a great many are now imported into England.

One English race has already been held in connection with the Harmsworth cup, the winning boat being built by Mr. Napier, designed by Mr. Edde, and carrying a strictly automobile engine, used in Mr. Edde's automobile in his Paris-Berlin race two years ago. The Thornycrofts have also taken up the gasoline launch with some activity. It promises to be an interesting season next year in England, and also in France, with international races in these automobile launches as they may be strictly called. An exposition of gasoline launches is to take place next year at Monaco, in France, and will be supplemented by racing, to which only the boats shown in the exposition will be eligible. There will be some prizes for motors using petroleum, and of each prize ten per cent. goes to the builder of the hull and ten per cent. to the builder of the motor out of the total prize to go to the boat. This question of international races suggests a necessity for international rules in which this country shall participate. Within the past four years we have formed in New York a national motor boat association which has done something to

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secure uniformity in the timing of races and in the rating of boats and motors. It has made quite an appreciable start and we may anticipate considerable progress in the near future, as many engineers are at present interested in it.

The launches we have had in this country up to the past year are not properly speed launches in that there has been no attempt to over refine the weight of engines. They are practically service launches, intended for general use.

I have some data here concerning Mr. Leighton's boat *Zaza* which was given me by the owner. The boat is 35 feet over all, 5 feet 4 inches breadth extreme, 5 feet breadth on the water line, and about 10 inches draft. She is copper built and rather heavy; the planking is 3-4 inch below the water and 5-8 above; the frames 3-4 by 1 1-4 inches spaced 9 inches, and by a curious process laid flat and not on edge. The bilge keelsons which carry the engine are 25 feet long, 14 inches deep in the middle, and 1 1-2 inches thick. The motor originally was a 6 by 5 Leighton, three cylinders. This year a fourth cylinder was added by an extension of the bed plate, and it has been run through the season, making about 650 turns, at its best. The weight of the present motor is about 950 pounds, for about 25 horse power, and 1,200 pounds with multipliers, etc. The screw is 22 inches in diameter, 28 pitch, three blades.

From numerous timed runs the boat is accredited a speed of 18 miles, which is doing excellent work for her type, which is not a true speed launch but the regular service type.

On the engine of the *Pink* a small port is cut in the compression chamber in the base, which is uncovered on the upstroke of the piston, and takes in a very small charge of free air. This seems to give twenty to thirty thrusts more per minute with a little increase in the consumption of gasoline.

There is one other important question in connection with these motors which are really more than gasoline motors, and that is fuel. The demand for gasoline for these boats is increasing very fast and it is a question what other fuels are available. In France for about three years past, through the Department of Agriculture, very strong efforts have been made to promote the production of alcohol by small farmers. The French government has given prizes for all kinds of apparatus for using *alcohol de naturæ*, or debased alcohol as it is called not fit for consumption, for lighting, and heating apparatus. In nearly every race that is run there is at least one supplemental prize for those using alcohol in place of gasoline, and as this alcohol can be made from almost any ordinary farm product, it promises to play an important part in the development of the explosive motor in France and Germany. Thus far we are only using gasoline here.

The Chairman: Commander de Faraman, of the French Navy, who is with us this morning, has kindly consented to give us some information which will be appended to the discussion.

Mr. Stratton: I would like to make a few remarks in contribution to the history of this matter. I believe that Mr. Charles Haswell has the honor of having built the first miniature steam boat in this country which may be styled a launch and which is a side-wheel boat, I believe. The second boat as a miniature steamboat was built by the Collins Steamship Company and used on Flushing bay about 1859 or 1860, to experiment in the various kinds of rotary paddle wheels. The boat was built by the Novelty Iron Works, and the entire summer was devoted in the use of this boat in various experiments. The first steam launch that I know of existing in this harbor was brought out by Mr. Jacob Lorillard, who introduced the Root square rotary engine and square piston, and I think that was in 1860, and to him belongs the honor of having first developed successful steam launches in this country.

Mr. Lucas: I wish to draw your attention to the fact that this class of boats has a very shallow draft and rather a high free board, and it appears to me that there is a great possibility for increased speed by immersing them deeper and having less free board, retaining simply the same hull and the same hull weights, and giving the additional amount of displacement entirely to machinery and increased amount of fuel. These boats are built for smooth water, and therefore do not need the excessive free board that most of them show, and I believe most of them will have the necessary strength for these smooth-water conditions that they could stand an additional amount of immersion. Another feature which is very important in connection with this style of boat, which are pretty nearly all of the flat-stern torpedo-boat type, is that their stern ought not to be immersed in the water; their knuckles should be at the water line and not in the water. I think this brings with it a necessity for a very close calculation of the weights in the longitudinal position to determine the trim of the boat. All additional immersion ought to come in such a manner that the water lines should radiate out from the sharp knuckle at the stern, and should not be parallel with each other as they are in the *Noma* to-day.

Mr. Crane: There is one point which has not been called attention to, and that is very interesting, about gasoline-engine development, that is the extremely light weight per horse power. The lightest torpedo-boat machinery weighs 35 pounds per indicated horse power, that including boilers and necessary auxiliaries. Engines of a larger size have been built that weighed 16 pounds per brake horse power. With the weight of machinery reduced to 16 pounds per indicated horse power at once there comes the possibility of greater speed in a self-propelled boat than we have ever had before by increasing our power on the same displacement or by decreasing the displacement. The light draft of almost all the boats shown in the sketches is due to the extreme lightness of the machinery, and the surprise is that more than forty or fifty or one hundred horse power is placed in boats of the smaller dimensions.

Mr. Ferguson: I don't think that will apply to boats when you get to any size. Take a boat up to say the size of the *Arrow*, about 75 tons perhaps, now her machinery gets down to about 17 pounds to the horse power, including the auxiliary machinery, electric-lighting machinery, and everything that goes with it, water in the boilers. Now, as soon as you get a gas engine of any horse power, that is of such horse power with a multiplication of cylinders, a small engine won't answer the purpose. You immediately get enormous weights, more weights than a steam plant of the same horse power, and while for small launches you can perhaps get a speed up by a multiplication of cylinders, it would be possible to ob-

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tain a speed of 30 to 32 knots, still I don't think it would ever be possible unless the lines of the engines are very much improved, by which you could obtain anything like the speed you get out of a steam vessel, say 35 or 40 knots, which is possible. So it would seem that the gasoline motor for fast boats would be confined to small boats where you use quite a number of small cylinders, but not for a boat requiring sufficient power to have an ordinary good-sized cylinder.

I would like to recommend to those members of the society who have these trials in charge, that they make official records that one could rely upon. I notice in going over all these boats and trying to find out what they have done, we get all sorts of unreliable reports. Of course I understand most of this is done for commercial purposes, but I think sooner or later this class of boat is bound to be taken up by people who have heretofore dealt with steamers, and that they will begin to realize the importance of getting some reliable results on record, and I think we would do more toward the advancement of the gas boat than perhaps any other thing that could be done at the present time.

I have often been asked where the distinction lay between a launch and a yacht, and have always been unable to answer it, except on the hypothesis that in the old navy we used to have a boat on a fair boom which was called a launch and which I think was 27 feet in length. That was called a launch, as I understand it, because they had to launch it; it wasn't carried at the davits, it was launched from the vessel, and when steam was put into that boat it still retained the name of launch. Why a boat that is 75 feet long, without any cabin on it, should be called a launch I can't comprehend. The mere fact of putting a cabin on to a boat 30 feet long seems to change it from a launch to a yacht in the estimation of the public. If anybody can give me any information on that point as to where a launch ends and a yacht commences I should be very glad to know.

MR. COX: The economy of running a launch, on basis of the consumption per horse power and the price of the two fuels, makes the gasoline vessels show up very badly, but there are other facts to be taken into consideration. That is to say, with the use of gasoline the force required to handle the boat is considerably less. With 200 or more horse power one man can take care of the engine, and then again with the gasoline there is no question of ever banking the fires or making fires. If you want a fire you go down and start it or try to start it, as the case may be. But you don't have to get up steam pressure, nor to waste coal in doing so.

SECOND SESSION.

The President called the meeting to order and the following papers were taken up:

SOME THOUGHTS ON THE DESIGN OF MODERN STEAM YACHTS.

BY CLINTON H. CRANE, ASSOCIATE.

ABSTRACT.

One scarcely realizes the rapid growth in our steam yacht fleet as revealed by the register of yachts, which shows 433 steam yachts of American ownership with a total of nearly 60,000 gross tons. Half of this tonnage has been built since 1890, and thirty-three, of about a third of the tonnage, are of English design and build. One hundred and eight of these vessels, of about 47,000 gross tons, are over 120 feet water line length. The yachts are classed under two general headings of ferryboat, for taking the owner from his country place to the city, and cruisers. The appearance of the English yacht among our fleets has stimulated American designers to produce vessels of better sea-going qualities and of improved outside appearance. On the other hand, American yachts have as a rule been faster boats, and, in regard to ventilation and plumbing, are much superior to the English yacht. At the same time we have been able to obtain a higher speed without increasing weight or space taken up by machinery, for in the American boat the water-tube boiler is quite generally used, while the English one is equipped with Scotch boilers. A speed curve is drawn which the author commented on in the discussion below.

The influence of the registration societies in requiring strong construction has been to develop a splendid class of vessels. The remaining page of this paper describes the steam yacht *Noma*, which is 252 feet over all and 226 feet on the water line. Her speed on trial was over 19 knots. Twenty-two per cent. of her displacement of 1,035 tons is devoted to the machinery. A full set of drawings of the *Noma* is added.

DISCUSSION.

MR. CRANE: I should like to say in explanation of this typical yacht-speed curve that it is drawn with a speed equal to the square root of the vessel's length taken as a unit and the power required for this speed as one hundred, that no exact figures are required or supposed to be given by the curve. The curve merely shows the general rate of increase of power of a vessel of yacht form, and the way the various vessels are placed on the curve shows the relation of their speed to the square roots of their length; that is, a boat whose length is 100 feet and whose speed was 11 knots would be at a point on the curve at 1 1-10 on the base measurement. I should like to further add that the speeds given in this table are the best authentic speeds in the knowledge of the writer. Many of these boats may have exceeded these speeds, but I know they have attained as high as the speeds given.

MR. SADLER: There are some rather interesting points in this paper raised by Mr. Crane. The design and construction of large steam yachts or steam vachts of any kind always seems to me to be more or less of an experimental nature for the other branches of this profession. There has no doubt been a good deal of work done in steam yacht construction in getting people to use water-tube boilers. I think with the exception of the navy and steam yacht work you may say that practically the water-tube boiler has not been looked upon with much favor in the merchant marine.

Those of us who have had to deal with the strength of vessels of this character know very well that Lloyd's requirements are amply sufficient for any service that the vessel is likely to encounter. In fact, personally, I think that the scantlings as required by Lloyd's could be considerably reduced, basing the calculations on the results of certain channel steamers that run across from England to France, which are built according to the Board of Trade. Those scantlings are very much less

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than the corresponding scantlings of the vessels of the same size of the yacht type, and they have to do pretty much the same service; that is, carrying practically no cargo, simply coal and passengers. So I think with the steam yacht we might make still further advance in the way of speed by the reduction of weight in scantlings. And there is one other point about the general shape of these vessels. We know that when we get into vessels of this size, the size of the *Noma*, say from 220 feet, that the form that is most easily driven at that rate of speed is one of rather full amidship section and fine ends. The original shape of the amidship section of the steam yacht developed from the sailing yacht, and it seems to me that when we are aiming at speed and are going to use steam as our method of propulsion, there is no reason why we should not adopt the best form that is used in other lines of steam propulsion, and not necessarily the yacht form. I think myself that a higher speed could be obtained on vessels of this dimension by a modification of form, especially in the amidship section and in the after ends of the vessel. I am glad to hear of Mr. Crane's surprise at the tightness of screw joints in boilers of this type, which seems to be a regular bogy to most engineers.

MR. STEVENS: Mr. Chairman, the question of form of yachts having been raised, I would like to ask some of the yacht designers here the reason for the peculiar formation of the ends which have become typical of our steam yachts. The bow always struck me as the remainder of the clipper ship and sailing frigate type, in which it was necessary to support a long bowsprit on account of the enormous head sail. The steam yacht seems to be carrying a bowsprit, and it seems to me to be absolutely useless and an expenditure of weight, carrying that form there, and it always struck me in looking at it as unnecessary. The same applies to the stern. It seems to me to be a copy of the old plank on edge type of the old English cutter, in which it was necessary to provide practically an outrigger to hand in your boom, and I suppose the stern is carried out on deck to provide room for the average Englishman's foot.

It has always struck me that the two ends of the vessel represented an expenditure of weight and an expenditure of bulk at places where they were of very little assistance to the ship. That is to say, if they could incorporate the same amount of weight and bulk in the body of the ship I think it would be of greater advantage. I never tried to design a steam yacht, and, therefore, I put these suggestions mainly in the form of questions and not as criticisms, and also to see whether, as matter of fact, these forms are not forced mainly by the requirements of owners on the supposition that they impart beauty to the form. To my eye, a well-proportioned, well-designed, modern cruiser is as beautiful, if not more beautiful, than the yacht.

MR. PACKARD: I was very much interested in Mr. Stevens' colloquy because we have had several cases where owners have forced us to build long ends. The main argument for the overhang bow and stern is in the first place more deck room, and, second, in a sea way the greater length is a decided advantage—it makes the boat decidedly easier in the sea, dryer, and on that account it is an advantage, and on the other hand for a high-speed boat there is no question but that much shorter ends, very much on the type of the cruiser, would be of a decided advantage. We have tried to persuade two or three owners, however, to have ends of that kind, and they have utterly refused when they saw a boat like the *Corsair* and the *Noma* or any of those large boats.

THE CHAIRMAN: In view of the large number of water-tube boilers fitted on our yachts I would think we might hear something more on the water-tube boiler question. If we cannot start a controversy about water-tube boilers I should like to call the attention of the society to the statement of Mr. Crane that the *Noma* is fitted with large bilge keels, which apparently do not interfere with her speed. I believe that is a matter as to which there is a great deal of difference of opinion. I recall in the case of two torpedo-boat destroyers which were recently built, the contractors were very much prejudiced against bilge keels, boats built on their own lines, and one of the requirements by the department before they were given the contract was to put in bilge keels. They objected to that very much, thinking that would interfere with the speed. It so happened that finally two boats, just alike, were tried, one with bilge keels and one without. The one with bilge keels, if I am not mistaken, did a shade the best, but it was thought that there was some other reason for it. The facts in the case apparently being that the bilge keels had no appreciable effect.

We have made some experiments in the model basin with 20-foot models built with bilge keels and without; so far as our experiments go they would indicate that the additional resistance of the bilge keels, if they are properly fitted—we haven't tried yet any improperly fitted—was never greater than the additional wetted surface. Of course if you fit a bilge keel so that the water does not come fairly at it you are likely to get an eddy behind it and increased resistance, but the bilge keel on a fair line apparently does not increase the difference. There are great differences of opinion on that subject, I believe, among naval architects.

With reference to Prof. Sadler's discussion on the fullness of the amidship section of these boats, I expect you will find that these boats have a very fine block coefficient, and the prismatic coefficient of the *Noma* is given as .601. Her block coefficient was probably in the neighborhood of .45 or .48.

MR. CRANE: It was never figured.

MR. PACKARD: You will find that such a low block coefficient if you give the amidship section the whole of the displacement, the displacement will be concentrated amidships, and it is very difficult to get any sort of lines on the ends. I think that Prof. Sadler is right in saying that full amidship sections associated with fine ends are quite fast, certainly in smooth water. That can't be carried too far, however, because if you push the speed up beyond a certain limit you find that the fine ends are objectionable. We have tested a number of models with fine ends and full ends in connection with the proposed 1,200-ton type of boat, which was to make 24 or 25 knots. But it so happened that at about 24 knots, with this length which was 280 feet, there was not very much difference between the fine ends and the full ends, but above that, the speed for the full ends was much lowered. Below that speed the fine-ended models drove easily. I think the reason for that is simply that with

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very fine ends as soon as you get up to a very high speed, why the whole bulk of your boat is affecting the resistance and you lose the result of the fine ends. In the full ends you get the advantage of the whole length of your boat in pushing the water out of the way. At those very high rates of speed it is not so much a question of fine lines as brute force, pushing the water—that is, of course, 22 knots on a length of 280 feet, which is quite a bit above the speed of the *Noma*.

MR. ROBERTS: Mr. Chairman, I rise to respond to your inquiry as to why water-tube boiler men don't have something more to say in regard to this matter. I think there is a very good reason for it. The fact that to my belief at least 90 per cent. of the steam yachts in the United States are fitted with water-tube boilers, and that at least 90 per cent. of these water-tube boilers have screw joints, speaks for itself.

MR. CRANE: The shape of the modern yacht amidship section I think is unquestionably of no advantage to her in smooth water, but I do think that a sharp section makes a boat faster and easier in a sea, and I think it is for that reason that yachtsmen have held to the sharp section of their steam yachts, for yachts as a rule are small vessels, and for their size they encounter larger seas more frequently than other ships.

In regard to the bow and stern, as Mr. Stevens imagines, it is entirely a matter of style. It is a question of the public taste of the yachtsman. If style required a straight or a ram bow and a short stern the yachtsman would have it. There is no question at all that it has come down from the old-fashioned clipper shape. As far as the stern goes it has a certain advantage in itself in that it gives a larger quarter deck and that is a thing which many owners wish.

WATERTIGHT SUBDIVISION OF WARSHIPS.

BY WILLIAM HOVGAARD, COMMANDER ROYAL DANISH NAVY, MEMBER.

ABSTRACT.

The author first points out that the safety of a ship is dependent primarily on two factors: buoyancy and stability; but in most classes of warships, more on the latter than on the former. It being further assumed that no practicable amount of armor or other protection will be sufficient to prevent the piercing of the shell, it results that safety, with reference to both buoyancy and stability, will require the subdivision of the internal volume of the hull in order to minimize the consequences of a rupture of the skin at any given point. The author thus takes it as a general principle that "whenever internal arrangements necessitate or favor a subdivision in compartments, these ought to be made watertight." The general effect of the flooding of such compartments is then discussed, the various cases being noted where the compartment is completely or partially filled, where it contains imprisoned air, and where it lies partly above the level of the outside water.

In order to first discuss certain general points the author takes a box-shaped form, thus furnishing a simple case for the fundamental discussion of the questions involved. The application of the formulæ and conclusions to the case of the ship-shaped form are then discussed with reference to the actual problems presented. The discussion of the relative effects of a broad transverse central, or of narrow longitudinal side compartments is also taken up, and with reference to the consequences in any concrete case.

The application of these general principles to the structure of modern warships is then taken up and the various practicable dispositions are discussed. With reference to the lower part of the structure the author concludes that the immersed portion of the shell should always, as far as the size of the ship will permit, be doubled, and further that the vertical keel should not be made watertight. The effects of wing-passage bulkheads, of side-bunker bulkheads, and of relatively small subdivision fore and aft are then discussed and their advantages pointed out with reference to the requirements of the general problem under discussion.

The author further concludes that the fitting of a watertight longitudinal center-line bulkhead is objectionable on the score of stability, and should not be fitted unless absolutely required in order to assure the efficiency of the ship in certain respects, as, for example, between the engine rooms on a twin-screw ship in order to avoid the possibility of both being flooded as the result of a break on one side.

The paper is accompanied by numerous diagrams illustrating various methods of subdivision, and with especial reference to the particular features presented for consideration by the author in the general discussion of the problem.

DISCUSSION.

MR. LUCAS: It is my opinion that the possibilities of the protected cruiser have not been exhausted yet, and it may be possible to find arrangements in a protective-deck position that will enable the protected cruiser to retain its entire reserve buoyancy and a very large percentage of its stability, even for injured condition. I believe at the present time the position of the protective deck is chosen too much in regard to the so-called "normal condition" of the boat, while I believe that an improvement in buoyancy and stability can be realized if the position of the protective deck would be chosen in regard to the maximum load condition. If the space below the protective deck would provide buoyancy in excess of this maximum full-load weight it seems nothing except perforation of the protective deck could deprive the boat of its reserve buoyancy. To obtain this maximum load position always for fighting purposes it would be necessary to provide a certain amount of water ballast that would take the place of consumed coal ammunition or stores. With the immense pumping arrangements, however, that every warship possesses, and the large subdivision of water bottom and watertight compartments, this would prove no difficult task. The cruiser could steam at high speed in a cruising condition; it would be permissible to have a rather steep angle for the slope of the protective deck, thus widening the area of the flat top very considerably, even to such an extent that it would be possible to realize positive stability if almost the entire superstructure is destroyed in regard to providing buoyancy leverage. If such a thing would be possible the protected cruiser certainly would lose a great many of the objections that are justly raised against it at the present time and the fine speed possibilities that are in this type of vessel will always retain favor for it in all navies.

MR. HILL: If the members of the society have not

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heard of the late collision in the English Channel squadron it may be interesting to state that the *Hannibal* collided with the *Prince George* one night. They were running at night without lights, and in ramming the latter made a long broken cut fifteen feet in length and five other holes broken through the surface. The rudder was disabled and the electric-light plant put out of commission, so that the ship was left in absolute darkness, but they managed to get the watertight compartments closed. The water kept gaining and she began to settle at the stern, but they finally succeeded in stopping up the jagged holes and at once set the engines going ahead at full speed. The pumps managed to hold the water down, so that running all night they reached Fayall in France next morning and managed to navigate her into the harbor, and then got a big cruiser alongside of her, pumped her out, and in 117 working hours, working with the men on the fleet alone, with no assistance whatever from the shore, they repaired her so that she was sent back to England, passing through a storm in the Bay of Biscay and reached England perfectly dry. They were both under way at 12 knots. I was with the English fleet during the summer maneuvers and I noticed in every case everything that approached to a protected cruiser was kept carefully under the wings of the mother battleships as long as any armored cruisers were in sight, and were absolutely useless except keeping a certain number of boxes, officers, and men in rather an exposed position.

MR. TAYLOR: With regard to the *Victoria-Camperdown* collision, I think that was at low speed, not over four knots, and I think in other cases also the cause of actual collision was they were trying to avoid a collision instead of trying to ram, and therefore the result was that the ramming ship struck the ship that was rammed at a comparatively low speed. The conditions would be rather different if the ship struck were rammed by a ship going at ten or twelve knots, and if a large ship strikes another going ten or twelve knots it will probably go down with her. There is no question about that.

I fully agree that the large-sized protected cruiser may now be considered an obsolete type, although there is now a movement in our service to revert to the large-sized protected cruiser, I think it is a practical waste of money. The protected cruiser which relied upon its sloping deflected deck to keep out the shot or the shell had some justification a few years ago, but the developments of high explosives and recent increase in the velocity of projectiles within the last ten years have rendered it practically worthless.

The remarks about watertight doors and the necessity for not having them below the water are undoubtedly true, but it seems very difficult in our service to make the practice conform to the theory. We had a case of a ship, the *Texas*, which was designed very much on the German plan; there were no watertight doors in the principal bulkheads below, and to get forward and aft you had to go through a passage directly underneath the protected deck in the center line. The *Texas* hadn't been in commission three months before it was reported absolutely impossible to carry on the work of the ship unless doors were cut in the bulkhead sections below. The doors were cut.

MR. BOWLES: I know the story about those doors very well, and it has a sequel which you may not all remember. Somebody took down the injection pipe on the *Texas* and failed to blank the injection valve, and in order to make sure that it was perfectly tight it was probably set up with a large wrench, and the result was that the injection valve broke and the ship was flooded, and due to these very doors the ship was sunk. That was an accident. At the times the *Texas* was designed the scantlings of the bulkheads were quite different from what they are now, and it wasn't customary to test the watertightness of the bulkheads in accordance with the present practice. It may not be well understood that in the building of all the vessels of the United States Navy at the present time it is customary to test all the bulkheads under a considerable head of water, a greater head than they would be liable to be subjected to under any conditions of damage, and those bulkheads are required to be tight and not to deflect beyond their elastic limits.

COMMANDER HOVGAARD: Protected cruisers are obsolete; smaller cruisers must be given protection and can never be termed anything but protected cruisers. I maintain it is better to put the armor flat on the side of the ship than to place it sloping as it is on the protected cruisers, because they would not thereby be transformed into armored cruisers in any sense of the word, because the armor will always be very light, and must necessarily be so.

It is quite true that speeds may be much greater in ramming than when the *Camperdown* rammed *Victoria*, but it must be remembered that the *Camperdown* was so seriously damaged by the collision that she drew four feet more forward after the collision than before, and that she might have been placed in a very difficult position. That shows if ships want to ram another ship at high speed they should be prepared themselves for going down at the same time. In the English Navy, where they have attempted to reduce the number of watertight doors, it has led to a great deal of trouble in the service, and they have had to increase the number of doors to one in almost every part of the ship.

NON-CORROSIVE NICKEL-STEEL BOILER TUBES.

BY ALBERT LADD COLBY, GUEST.

ABSTRACT.

In view of the great prominence which has been given recently to the study of marine boilers, the question of the life of the tube has been a most important feature. The paper contains the substance of the writer's interviews abroad in connection with the development and the manufacture of nickel-steel tubes. The tests of these tubes indicate that they will last two and one-third times as long as mild carbon-steel tubes. Their increased strength and non-corrosive properties permit the adoption of lighter gauges than are at present in use. In France the manufacture of the nickel-steel tubes was begun commercially in 1898, and in Germany the following year, and the German, French, and Holland navies at once investigated the merits of these tubes. In France the Ehrhardt process is used, which consists of punching out of a square billet. The following operations are much more numerous than those required for the seamless tube, and frequent annealing of the nickel

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steel has been found necessary. The resulting cost is excessive. The nickel-steel tube is made in Germany by the cupping process from disks cut from rolled plates. Although the first high nickel-steel boiler tube was made in America as recently as February, yet so successful has the manufacturing been carried out that 30 per cent. of the nickel-steel seamless cold-drawn marine boiler tubes have been a commercial product for some time, and are made in practically the same number of operations and at but a slightly greater percentage of discard for the manufacture of ordinary seamless tubes. These tubes will successfully stand all the tests specified by the Bureau of Steam Engineering of our navy. Because of the increased strength of the nickel steel a larger gauge may be used, and it is estimated that the saving in weight for the boilers of a torpedo-boat destroyer would be 10.7 tons, and that of a battleship 38 tons. The added cost of the 30 per cent. nickel steel would be little over twice as much in the first case and two and two-thirds as much for the battleship. This extra cost, however, is not prohibitory, considering the fact that the nickel-steel tube will last two and one-third times as long as carbon-steel tube, and when finally taken out has a high market value as nickel scrap.

The author gives Mr. Yarrow's summary of the probable causes of deterioration in a marine boiler, and then describes the latter's comparative tests of specimens of 25 per cent. nickel-steel and mild carbon tubes. All the tests to determine the action of acids in the water, the result of tubes becoming overheated, and the action of superheated steam, showed most remarkable advantages for the nickel-steel tube. Nickel steel has a tensile stress of about one and two-thirds that of carbon steel, and at the same time the percentage of elongation is no less than the carbon steel. An interesting series of tests made by the French Navy to determine the physical properties of a lot of French 25 per cent. nickel-steel tubes is given; and tests conducted by Mr. Yarrow and by the Shelby Steel Tube Company of this country gave evidence of the ductility and the absence of all brittleness of this metal. Another advantage of nickel steel is that it is homogeneous throughout. These tubes are applicable in many lines of engineering, and tests made of them on condensers, superheaters, stationary boilers, and in automobile boilers, where the tube has to be coiled and is made of one long piece, show up most advantageously.

DISCUSSION.

MR. THOMPSON: Assuming Mr. Colby's facts that in the battleships he can save forty tons of weight at a nominal increased cost of $56,000, then, as each ton on one of our modern battleships that is available for armor or for machinery or for guns or munition costs about $500 a ton, there is a saving equivalent to $20,000 in that saving of weight. That would reduce your extra cost to about $36,000, which is only about one per cent. of the contract price for a battleship. Now, if you can increase the length of time in which the boilers will be effective, two or three times, at an extra expense of one per cent., there can be no question what the government ought to do in a case of that kind and what the government will do in a case of that kind. In a torpedo boat I figure out the situation is even better, because there the cost of each ton available for the purposes of the torpedo boat is about $1,000, which makes the increased cost of the nickel tubes only about $4,000.

Many of the vessels of the battle fleet which I saw this summer under the conditions of actual warfare, broke down, their defects occurring in the boilers and through their crews not being trained and accustomed to handle them at the high pressure necessary. Anything of this kind that would tend to decrease the chances of such elements must be considered of importance.

MR. PRATT: The life of all boilers is practically based on a two and one-third times the life of the tubes, and it is possible to produce a nickel tube which will last two and one-third times the life of the low-carbon steel tube; there is great advantage for the nickel steel, for with the boiler tubes it isn't a question of strength so much—it is a question of having the thickness available for deterioration, and if you can get a tube that will not deteriorate then you can make your tubes thinner and save a great deal of waste.

MR. THOMPSON: There were, at the works of the Waclerk Wire Company, two boilers; one at the time built was built of nickel steel and the other of ordinary steel; which was found after running a certain length of time the nickel-steel tubes became very smooth or polished or glossy, and there was no tendency for oil or scale to adhere to them, and in the case of the other boilers they had become picked and rough and oil and scale would adhere. For several months a careful record was kept—for eighteen months in fact—and the saving in the nickel-steel boiler amounted to about seven per cent. as compared with the other boiler.

THE CHAIRMAN: The Chair would state that in his own experience in one case there seems to arise a doubt as to whether mild carbon steel was not injured by cold bending, so as to cause them to be especially liable to this deterioration by pitting. Other tubes, that is, tubes of proper material and properly bent, did not seem to be affected at all injuriously, but one set of tubes was affected. The effect seemed to center itself at the position where they had been bent cold and seemed to be due to the quality of the material used.

MR. COLBY: I would like to answer the chair in reference to the subject of bending, that in the first place there is absolutely no deficiency in bending in the nickel-steel tube. It will stand exactly the same amount of cold bending as the low-carbon steel will stand. This is illustrated in this bending and flattening test, in which the deformation had been far greater than any requirements which mild-carbon steel tubes are asked to meet. Furthermore, in reference to the local failure of steel tubes, where they are bent, I think there is no doubt that the nickel steel will be more advantageous in this regard, for the reason it does not have as high a contraction of area as the soft-carbon steel. For that reason I think you will find that in practice there will be a marked advantage in the wear of nickel-steel tubes at the points in which they are bent. That is further illustrated in the success which these tubes have met in their introduction in France for the automobile boilers of the Garnier-Suppolet type of steam boilers. There is another property of this 30 per cent. nickel steel which renders it very advantageous for this purpose, and that is, if it is heated red hot and plunged into cold water it softens it and not hardens it; which is exactly opposite

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what you would expect from your experience in testing ordinary steel.

CURVES OF FORM OF THE INITIAL CONDITION.

BY GEORGE C. COOK, MEMBER.

ABSTRACT.

In this paper the author presents a general discussion of the various geometrical functions and ratios which depend on the external form of the submerged body of the ship. These are furthermore limited to the so-called "initial position"—that is, ship upright and in normal trim. These various geometrical functions relate to volumes, areas of sections and water planes, center of volume and of area, metacenters, moment for change of trim, form coefficients, etc.

The paper is accompanied by a collection of analytical expressions indicating the operations of integration required to determine these various quantities, and by a series of plates showing the resulting curves in various illustrative cases.

These various geometrical functions and ratios are all well known to the naval architect and form the subject of the usual elementary computations in all drawing offices.

The meeting adjourned until 10 o'clock Friday morning, November 20, 1903.

THIRD TECHNICAL SECTION.

The Friday morning session was called to order at 10 o'clock with Mr. McFarland in the chair, who requested the reading of the following paper:

THE METRIC SYSTEM IN RELATION TO THE SHIPBUILDING INDUSTRY OF THE UNITED STATES.

BY NAVAL CONSTRUCTOR J. H. LINNARD, U. S. N.

ABSTRACT.

The author first notes the recent agitation in favor of the metric system and which culminated in H. R. Bill No. 123, providing for the compulsory use of this system in all departments of the government work except in the completion of the survey of public lands, and for the legalization on and after January 1, 1907, of the weights and measures of the metric system as the standard weights and measures of and in the United States. It is then pointed out that should such legislation become operative all shipyards in which government work is done would needs adjust themselves immediately to this requirement and carry out all such work on a metric basis. The author then discusses the general question of the applicability of the metric system to engineering work in general, and in particular to the art of shipbuilding, and concludes that from all practical points of view the present or English system is greatly superior. Reference is made to the advantages of a decimal system of notation, and it is pointed out that such advantages may be obtained by a decimal subdivision of the foot and inch as is now quite common in many fields of engineering work. Reference is further made to the character and size of the units furnished by the metric system, and to their unsatisfactory nature for certain purposes, such as the specification of screw threads.

The author then calls attention to the enormous loss in vested interests which would result from the wholesale adoption of the metric system, such as machinery for the production of standard structural forms, and likewise all data, tables, drawings, and the entire literature of the art so far as found in the English language. Special reference is also made to the mental concept of size or dimension, which is so necessary a part of the equipment of every good mechanic, and of the difficulty which would be experienced among mechanics in attempting to adjust themselves to a series of units wholly different from those with which they have been acquainted during their entire preceding life.

The paper as a whole forms a strong argument from the shipbuilder's standpoint why such legislation as that proposed in the bill referred to should not be allowed to become operative.

DISCUSSION.

MR. HALSEY spoke at length on this subject, giving extracts from the voluminous evidence which he had gathered to show that the metric system is used very little even in the countries where compulsory legislation has been enacted. He went on to show that although it was claimed by its advocates that in forty-four countries the metric system was used by nearly four and a half million people, as a matter of fact in the thirty countries where he had investigated he found that most of the laws governing the system simply permitted it to be used in the country, and that further investigation revealed the fact that in these thirty countries it was practically never used. Many most interesting extracts from testimony gathered were shown. In Mexico, where the system has been adopted, the greatest confusion prevails in trade for goods such as iron bar bought and sold by the meter in length and the inch in diameter.

He states that the most striking feature of the present movement is that the scientific men favor the metric system while the manufacturers do not. The scientists' system is measuring the thing when it is done, while the manufacturers' system consists in making of things to specific sizes. Therefore, a change for the scientist would simply mean changing his measuring instrument, while the industrial change would require a complete change of the line of sizes. The scientist's argument is always a measuring argument, never a maker's argument. In closing the speaker stated that if the society is to go on record against the bill now before Congress for the introduction of the metric system, to have any effect a resolution should not be aimed against compulsory legislation, but rather against any change at all, for the present bill is not termed for compulsory adoption.

THE CHAIRMAN: I have given some attention to this subject and I was called before the committee on Coinage, Weights, and Measures as the representative of the company with which I am connected, under the belief that I would advocate the change to the metric system. The people there supposed I was very progressive, and I believe they were very much disappointed when they found that my ideas of progressiveness did not coincide with theirs; and I tried to make out that point that Mr. Halsey brought out very clearly, that the men who are advocating the measure are simply the scientific men—men who simply measure things after they are made—while the manufacturers, as far as I could find, were opposed to it. We had an estimate made for my company as to how much it would

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cost to make this change, and found that to make the necessary changes in chucks and tools and measuring instruments and things of that sort in the shop would cost nearly half a million dollars, and to change our drawings over would cost about a quarter of a million more. And the expression Mr. Linnard used about the importance of round numbers, I tried to emphasize that in my testimony; but it was a flat failure; the people not being manufacturers didn't appreciate it. I invited them to come out and go through our plant and let us show them what it means to make the change, but up to date they haven't come. I am still hoping that they will.

MR. FORBES: Mr. Halsey has proved, if he has proved anything, that we are in a state of chaos. It seems the gentleman who read the paper believes we are going to live forever. Can't we stand it for a short time for the benefit of by and by? Certainly the argument the gentleman presents proves we ought to do something, and it seems to me that after we have got a good start in any way to standardize measures throughout the world we ought to stick to it and not slide off to something else. I fail to see where the expense is going to come into my shop in adopting the system of measurements. I have no trouble at all in making my men work on the metric system, but I generally tell them I want them to make that so many lines long, so many marks, and they come out all right. I don't have any trouble with that. Talk about accuracy! I never saw a bar-rolled iron that was accurate. I never knew a 4-inch bar that was 4 inches; it is always plus. We all know that we have got chaos perhaps in one way, but why can't we attempt to better it and not pull down the structure unless you can give something that has made a decided advance? We cannot afford to batter down this structure of the metric system unless you are going to build up something better.

MR. PEABODY: The point in question is the one that was emphasized by Mr. Linnard in a very temperate and very judicious way, which is: shall the shipbuilding interests of the United States be made to carry the brunt of this when it probably is the worst possible place to try it? If the country can be brought to the place where the metric system is used generally, then the shipbuilding industry will fall in with it; but why should a government action be taken which is going to bear heavily upon one particular department, and that one which has sufficient difficulites of its own? On the scientific side, if the metric system is found more convenient then it is more scientific than any system in common use. I can't see how otherwise it can be claimed to be as scientific or more scientific.

While it is very true most of the papers, scientific sheetings, are using metrical units, if you will take the catalogue of any house in this country or in England selling scientific apparatus, you will find that there is nearly as much apparatus sold as graduated in other systems than the metric as in the metric system. There is no difficulty so far as I have seen in shipping materials to foreign countries on metric orders from a non-metric factory. Take the case of liquids for example. Our standard package for most liquids is a barrel which is called a 50-gallon cask, and holds from 45 to 52 gallons. You seldom will get two casks of the same capacity; they all have to be gauged; and if a man wants so many liters of liquid shipped to him, it is just exactly as easy to ship that as it is a corresponding number of gallons, because you have got to weigh it anyhow, and it is merely a matter of reducing one to the other.

Metric System Resolutions.

Mr. Hyde presented the following resolutions which were adopted by the society by a rising vote of 40 to 11:

Whereas, A bill for the adoption of the metric system in the departments of the Federal government has been favorably reported in the House of Representatives;

Whereas, We consider that the only effect of such a law will be the creation of a government metric system and the continuation of the existing system in ordinary commerce and industry;

Whereas, The confusion resulting from such a condition of things would be intolerable;

Whereas, We believe the adoption of the metric system of weights and measures by the people at large to be impracticable; therefore, be it

Resolved, By the Society of Naval Architects and Marine Engineers, assembled in annual meeting, that we condemn all legislation intended to promote the adoption of the metric system in this country;

Resolved, That we especially condemn the bill which was reported to the last House of Representatives as one which can do nothing but introduce confusion where we now have uniformity.

ELECTRICITY IN MANUFACTURING PLANTS.

BY W. M. M'FARLAND, MEMBER OF COUNCIL.

ABSTRACT.

The author first notes the great advances which have been made during the past ten years in the application of electricity for industrial purposes, and in particular for the distribution of power to the various points where required in large industrial establishments. The various advantages of such mode of distribution as compared with distribution by belts, shafting, steam piping, etc., are pointed out, and this section of the paper furnishes an excellent general comparison of these various methods of power distribution.

The author then passes to a discussion of the relative advantages of alternating and direct-current machinery, and points out that on this point opinions are still divergent, and presents simply his own views based on a wide experience with such machinery, and with a firm where both types are manufactured. In this connection the author suggests that had the induction motor been the first to enter the field there would have been little room for argument because its merits are so great that there would have been slight incentive to develop anything else. Due, however, to the fact that the first practicable forms of electric motor were of the direct-current type, the latter acquired a vogue which naturally belongs to a meritorious device to which the engineering public is accustomed and upon which it has for some years placed its dependence. The author then compares the essential structural elements of the two types of motor and expresses the opinion that for most industrial purposes the induction motor will be found superior to those of the direct-current type.

The author then discusses in some detail the various

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systems of installation, of speed control and variation, and gives numerous illustrations drawn chiefly from shipyard installations. The paper is also accompanied by numerous half-tone cuts showing various examples of such installations, and by a diagram showing the efficiency curves for two typical motors, one of alternate- and the other of direct-current type.

DISCUSSION.

MR. HERBERT: There is one point of the advantage for electric drive which came to my attention recently here in the city of New York. A double factory building had two lines of shafting run up on each side of the wall and a fire took place in the basement of one of the buildings and went through the hole in the wall where the shafting went through and followed right up through the belt boxes and gutted the whole building. The safeguard and advantage on account of fire with the electric drive are very evident.

MR. NEWMAN: Several years ago Professor Benjamin of the Key School of Mines estimated that to run a certain plant by electricity there would be a saving of at least 50 per cent. of that necessary to drive it under the old belt system. With the introduction of electric power in the shipyard of to-day we may look for at least 75 per cent. saving.

When a certain plant with which I was connected decided to install electricity we had a contract with the Westinghouse people at which they furnished the motors at a fixed price, and when they came to arranging our small tools we found we could get a 25-horse-power motor to drive the tool shop and so on, at a cost which was not comparable with that under the old belted plant.

The use of the magnet for lifting plates was first drawn to my attention by the sales agent of a Cleveland concern, but it was a rather expensive tool. Our consulting electrician, Dr. Robb, afterwards devised similar magnets for the same purpose at a cost which was really absurd in comparison with the cost of the magnet originally purchased. We tried it in Cleveland with rather indifferent success, and when I made my connection with the New York Shipbuilding Company it was adopted there. I am not sure whether it is used to-day or not; but there is no doubt in my mind that it is an appliance that can be used very extensively and to advantage.

MR. MCFARLAND: I didn't attempt to make this paper a very technical paper because I felt that before this society what is wanted about things of this kind is the results rather than an attempt to go into technical detail. Only yesterday one of our men called my attention to the adaptability of one of the forms of variable speed induction motors to quite a delicate service—paper making—where it had to be handled very delicately indeed in order to give success, and had worked admirably.

DESCRIPTION OF THE DESIGN AND BUILDING OF THE 21,000-TON STEAMSHIPS MINNESOTA AND DAKOTA.

BY CHARLES R. HANSCOM, MEMBER.

ABSTRACT.

This is a very complete account of the arrangement, building, and equipment of two of the new steamships for the Great Northern Railway Company, building at New London, Conn., by the Eastern Shipbuilding Company. Incidents regarding the selection of the site and erection of the buildings for the new shipyard which was established to build these great vessels form an introduction to the paper. The most novel feature of this yard is the trolley system for handling material above the two building berths. Three heavy steel masts were erected, 300 feet apart, between the building slips, and each supports a crossyard, 174 feet long, extending over the slip on each side. The structure is held in position by wire guys and a strongback placed on the after mast. The crossyards are fitted with tracks on which the carriages supporting the athwartship movable cable travel. The field of operation is divided in two parts by the middle of the yard, and over each belt runs a trolley with a lifting capacity of 5,000 pounds. The system was designed for two trolleys for each field. The electrically-operating machinery is located in a house on the mainmast.

The preparation of the building berths and the method of building the vessels are then described and the special features of construction are considered. There is a longitudinal bulkhead from end to end, from tank to main deck; forward of the machinery space on the tank top a tunnel is built which is watertight, passes through all bulkheads, and contains the ballast and bilge piping. It is entered through door in forward boiler room and has an escape to crew's quarters. The double bottom is 6 feet deep. The decks are supported by box-shaped girders and bracketed to bulkheads by heavy webs, with wide-spaced pillows between bulkheads. Two pairs of deep tanks, one forward and one aft, are arranged for cargo as well as water, and bring the total water ballast up to 5,000 tons. The auxiliary equipment of these vessels is most interesting and in many respects quite novel. The hatches are fitted in pairs, two to each hold, one port and one starboard of the longitudinal bulkhead, making 18 hatches in all. Extensive arrangement for handling cargo rapidly with derrick booms is installed, the winches being of electric drive. Sixteen Niclausse boilers are to furnish steam at 250 pounds pressure to two sets of triple-expansion engines.

The closing pages of the paper are devoted to a description of the launching of the *Minnesota*. The pressure on the forward poppets averaged about 13 tons per square foot, and the launching weight was 11,000 tons. The launch was carried out successfully. A most valuable set of drawings accompanies this paper, including midship section, layout of ways, details of stem and stern, arrangement of anchors and steering gear, engine and boilers, general arrangement plans of the decks, etc. Many fine engravings are also given, showing the ship before and after launching, and also launching diagrams. Coming, as this paper does, from the president of the company, it may be looked upon as authoritative.

In the absence of the author Mr. Main read the above paper.

DISCUSSION.

MR. STANBERRY: The vessel is building under the survey of Lloyd's Register. We have taken great pride in watching the progress of the work under, I might say, almost unprecedented difficulties. The contract, as you see by the preamble of the paper, was taken when there

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was no yard, no establishment actually fixed for it, let alone a plant to work with. The building of the ship you might say went on concurrently with the establishment of the yard, and the plant, and the building of the workshops. It is the most unique occurrence, I think, in the history of shipbuilding. Mr. Hanscom, in his paper, makes one reference to the wide spacing of pillar stanchions connecting with the overhead girders, and it reads as if that was the first time in which that system has been adopted under our classification. That is not quite correct, and would cause a little modification. I think in other yards, the Maryland Steel Company and the New York Shipbuilding Company, the system had been adopted and approved by our society.

MR. NEWMAN: I noticed in listening to this paper reference was made to the building of the ship from the middle body toward the ends. This of course is the usual practice adopted on the Great Lakes, where we build under that system and frame our ship as rapidly as possible. The idea of that is that we can get more men in operation than in any other way, and then as soon as she is framed and faired we can build from different stations. In other words, we could plate there a ship 500 feet long in five weeks. I think that is quite a record, and proves rather to me the absence of the necessity of attempting to shear in when you can do so quickly. Some two years ago the point had been raised by the late Mr. Morse as to which end to build the ship from to get the best progress, and we came to the conclusion that the stern was the first thing to start from; that is, we erected our stern post first and built forward. I gave to Mr. Nicholson the scheme to plot out and draw in diagrammatic forms and in different colors the progress of the ship in construction. They had a diagram of the ship on the keel and nothing else. Then we laid the floors in the different stages up, which proved very interesting, and those of you who are practical shipbuilders will realize the difficulties to be encountered in those methods because where the ship has this reverse shape there is practically nothing to hold the ship and the tendency is to hang back. In the first place I mentioned the sheer strake and the stringer did not come quite right, and after we learned the first lesson we got ahead of it and anticipated that difficulty in the next.

I notice further Mr. Hanscom's remarks about the efficiency of the pneumatic reamer, and latterly the thought that has struck me, especially in light constructions where we build with a template system and almost invariably ream and countersink bolts, why not go a step further and drill the work. I think the government, with their light shells and very much lighter scantlings, could consider this subject to advantage, and I don't think the cost would be as surprising as you might expect. The riveting in these ships becomes a very important and serious factor, and after discussing this same question with Lloyd's surveyors and the superintending captain of the Atlantic Transport line of boats on the two ships we were building, we adopted a scheme of increasing our riveting, and in changing we turned abruptly and tapered off diagonally at the ends, and I should say with pretty good results. I think the idea originated with Lloyd's surveyor. These large Atlantic boats are showing weeps in their deck tanks which are probably due to that one cause.

Mr. Hanscom's reference is also to the longitudinal framing adopted in these ships. I think this can be followed with advantage by many of our light high-speed boat builders. Mr. Hanscom calls himself the pioneer in heavy shipbuilding, and I want to state that hulls 5 and 6 of the New York Shipbuilding Company were but very little smaller, and I think are worthy of note. They were supposed to be sister ships to the *Minneapolis* and the *Minnehaha*. We lifted all the heavy weights from the main deck up to the upper deck, which was condemned by the naval architect, and they have yet to prove their improvement otherwise over their sister ships.

I think another interesting matter, too, in connection with these heavy boats is the riveting. When it comes to driving a 1 1-8 or a 1 1-4-inch rivet in these heavy plates it is a very serious problem, and we resorted to countersinking with a rounded head. In other words, the boat shear strake looked as though they were all strap driven, but they had underneath a countersink which gave very excellent results.

MR. PATTERSON: I will be pardoned, perhaps, if I correct the impression that Mr. Newman has made, that the origin of the design of carrying heavy class of the structure on top is due to the company with which he was formerly connected. Praise, if any, is due to the company with which I am connected, the International Mercantile Marine Company. And in the case of two boats that were first built and not ready, and two more building here in Cramps, the bridge house was worked to form a part of the upper weight. The details of the riveting, which have been explained by Mr. Newman, were first of all carried out in Cramps' yard, and were arrived at after prolonged and tearful experiments. The importance of closing up the plates properly and of getting the large rivets to the right seams was what moved us on two or three occasions in the overhaul of the large vessels owned by us. The title of the last paper mentions the designs of the ship, yet, although there is a good deal of scantling and a good deal of detail, the greater part of the paper is taken up by a description of the equipment. That of course is exceedingly interesting. I should be interested to hear of the displacement. Besides that, I have not been able to see in this paper anything about the weight nor anything about the stresses that are taken care of in that ship, and I expected to have heard also the reasons for carrying out such an extensive system of longitudinal framing in such a ship in which the racking strains would probably be excessive. The double girder in the center can hardly be justified. The experience of the owners will prove that. The other details are pretty closely copied from other big ships, which is, of course, to be expected. It is pretty easy to claim, but it is very hard to have accorded to you, a case of originality in the building of a ship to-day; for there is hardly anybody who can build a ship at all of that size anyway except by the experience gained by the other people who have had to pay for it, and by the great registers both of this country and of Europe.

I want to point out the details which have been admired in regard to the tapering off of the riveting, etc.

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Both have been in common practice for ten years, and that in the ships of the company that I have the honor to be connected with, in the *New York* and the *Paris*, which are pretty old boats to-day; in detail and strength and almost everything that makes the naval architect pleased, the lines of bulkheads that Mr. Newman has referred to and other parts have been most carefully considered. It was a pioneer operation, and everything was actually designed on paper. The experience of our company at that time had not been great with those big ships, but we had to go by the experience of the distinguished builders of those ships that were presided over by Professor Biles, and even to-day, anybody who is acquainted with the details of that ship, which are entirely due to him, will see how much the people of this country and the shipbuilders everywhere owe to the courage and the originality which were first of all embodied in those two ships.

I am far from trying to minimize the energy and the enterprise displayed at New London. The work done there is an example to all builders and also an object lesson to the investing public. It is not necessary to have an elaborate shipyard. A very ordinary plant can produce anything that can be built, and if there is any justification for a big plant it is that it will get you a perpetual promise of orders.

MR. MAIN: In answer to a remark of Mr. Newman regarding the use of pneumatic tubes, I might say in England Messrs. Yarrow and Thornycroft now drill through all thin plates with pneumatic tube. In answer for Mr. Hanscom, I do not think he intended to claim any originality for the construction of this ship.

In the absence of the author the next paper was read by Mr. Linnard.

ON SHIP'S FORMS DERIVED BY FORMULAE.

BY D. W. TAYLOR, NAVAL CONSTRUCTOR U. S. N., MEMBER OF COUNCIL.

ABSTRACT.

The author first refers to the various methods which have been put forward for deriving forms of ships from algebraic equations, and makes the point that the purpose in view in the method to be presented is not the derivation of a so-called "form of least resistance," but rather the provision of means for varying the characteristics of form systematically between certain specified limits, and for executing such changes more rapidly than would be possible by the ordinary method of hand-made lines, or lines derived by the usual drawing-board methods. The author then notes the unexepctedly great importance of variations in form, and cites examples drawn from experience in the experimental canal showing that moderate changes in the characteristics of form may sometimes produce a surprisingly great influence on the resistance.

In the appendix to the paper the derivation of the fundamental formulæ for both water lines and sections is given, and the equations are discussed in detail. The paper is accompanied by tables of numerical values relating to various constants entering into the equations, and by plates showing the forms of water lines and sections thus derived, and the influence of varying values of the arbitrary coefficients involved.

The paper as a whole shows in detail certain methods which have been found of use in connection with the investigation of problems in the government experimental canal, and indicates incidentally the complexity of such problems and the extent to which the details of the investigation may be carried.

DISCUSSION.

MR. LINNARD: The main object of the methods adopted by Naval Constructor Taylor, as all his work is highly original, is to evolve a system by which, starting from a given set of lines developed by mathematical formulæ, he can vary those particular forms in a regular and in a mathematically developed method, so that he may know exactly how he is proceeding from one set of lines to another set of lines. In other words, he replaces a haphazard method which failed to give the results he desired. The hand-made model has to be modified entirely by guesswork. The machine-made model is modified by mathematical processes in which the fulness is placed where it is thought desirable to put it and the fining is done where it is thought desirable to do it, and the coefficients and the curves and sectional areas are modified in certain directions without changing the displacement which has been determined upon.

Mr. Taylor's principal difficulties, which he touches on in the paper which I have read, arise from the double curves in the stern. The formulæ developed by him in the paper are not able to give the curves of this shape (indicating) of the double curvature. The other day Mr. Taylor told me that he now found a formula that would climb a tree, and he felt perfectly able to handle this matter.

MR. KAFER: We have in the experimental tanks an excellent means of a scientific study of the problem of resistance. It is now not many years ago, when there were only a few tanks in existence. At present there are quite a number of tanks, and the number is constantly increasing. Still, we are only at the threshold of the problem of how best to design a ship for a given speed and a given service; that is to say, we know in a general way what to do, but we can rarely be sure whether we could not so modify our design of a ship as to gain, perhaps, up to 10-20 per cent. The problem is one of extreme complexity and can, like most other scientific problems, only be solved through long and numerous series of experiments, in fact, series of series of experiments. Only if such data are available in a continuous and complete way, will it be possible to draw general conclusions or to tabulate results in such a way that an answer can be had to every reasonable question that may occur in design of the lines of a ship.

Continuing, Mr. Kafer pointed out that different experimental tanks were operated independently of each other, and that the information gathered was not given out. He classed the experiments under two general headings, that for commerce and navy work and that for scientific research, and stated that practically all the work was under the former head. He suggested that a certain time be allotted to carrying on scientific work, which should be published for the general good, such, for instance, as is carried on by the different astronomical observatories. The results thus compiled and published would be of immense value. The speaker looked upon Mr. Taylor's paper as the first step in this direction, namely, that of reducing the design of a ship to mathe-

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matic formula, and stated that he should be most heartily thanked for the work. The speaker had suggested to Mr. Taylor the advisability of calculating the curve of a batten considered as a flexible beam.

MR. COOK: May I ask if this table of calculations that Mr. Taylor gives here is applicable particularly to the battleship, or will it do for any vessel with equally good results? Also, at what expense are model experiments carried on for private owners?

MR. LINNARD: I can hardly answer the question in detail asked by the last speaker. I think it should be understood that the system of formulæ and curves laid down in this paper will not enable the tracer to turn out a ship, but will aid the expert naval architect, and their principal use at the present time is in determining within given principal dimensions and displacements the effect of variations of form within those limits.

COLONEL STEVENS: I have just had two models tested and the cost was $350 for the two, which about includes everything from the drawing of the lines. The lines were fair as lines are made fair in the drafting room, and sent to Washington, and the models were produced there and tested. The deposit requested was $500, of which about $150 was returned.

FOURTH SESSION.

The president called the meeting to order.

MR. LEWIS NIXON: I beg to call the attention of the society to the fact that we have suffered a loss by death of a number of the prominent members of this association, among whom were Chief Engineer D. P. Jones, U. S. Navy, Henry G. Morse, George Pierce, Irving M. Scott, Henry Steers, William R. Drake, and Professor R. H. Thurston. The loss of these gentlemen is a distinct loss to the entire engineering fraternity of the United States, and I am sure I am voicing the sentiments of this society in moving that a committee of three be appointed to prepare appropriate resolutions of sympathy for forwarding to the families of the deceased. I make that motion.

The motion being duly seconded and put to vote, was unanimously carried.

DISPLACEMENT AND STABILITY CALCULATIONS BY IMPROVED METHODS.

BY W. S. LELAND, MEMBER.

ABSTRACT.

In this paper the author presents the results of certain investigations relating to the arrangement in detail of some of the well-known computations for the geometrical qualities and functions of ship-shaped forms. These arrangements have been worked out with special reference to the use of students in classroom work, but the author believes that similar methods might be employed for actual shipyard calculations.

In the details of the arrangement various combinations of the trapezoidal, Simpson's, and Tchebycheff's rules are employed, together with mechanical integration where appropriate for stability computations. Comparisons are given showing the number of figures and operations required according to various arrangements of the computation sheet, and the gain by the use of the arrangement suggested is shown.

The paper is accompanied by sample sheets and forms, and by diagrams illustrating the methods of subdivision and representation employed.

THE CHAIRMAN: Gentlemen, Mr. Bauer's paper, No. 18, will now be distributed and considered as read, and discussed as a part of Prof. Leland's.

A GRAPHIC METHOD FOR THE CALCULATION OF THE STABILITY OF SHIPS.

BY M. H. BAUER.

ABSTRACT.

The author first calls attention to the fact that the methods hitherto employed for calculating the stability of ships have had as their object the determination of the lever arms for the ship in one given trim only, and heeled by an external force perpendicular to the length of the ship. He also points out the well-known fact that whenever a ship of ordinary form heels transversely the center of buoyancy moves forward or aft to some slight extent, and the heeling is thus accompanied by a change of trim as well. While this latter movement may be unimportant for ships of full form in normal trim, yet it may in special cases increase to a very considerable amount, as in the case of empty cargo steamers with machinery well aft, or ships with leaky end compartments.

In order to take proper account of all such cases the author proposes a series of positions of the ship, involving changes in displacement, heel and trim, and for each one of which the lever arms are computed with reference to both longitudinal and transverse axes. The number of variations in draft is three, for each of which the ship is given three positions in trim, and for each of the latter, three angles of heel. This gives twenty-seven selected positions of the ship for which the actual location of the center of buoyancy is found, thus giving in each case the two components of the total lever arm, one relative to inclination about a longitudinal axis, the other about a transverse axis. The determination of these various arms is supposed to be made by the aid of the planimeter and integrator, and by processes involving the usual and well-known mathematical formulæ which relate to this problem. When these component arms have been thus determined the values are plotted in a series of ways, as a result of which the arms corresponding to any specified set of conditions may be determined by reference to the suitable curve. The "graphical" character of the paper has chief reference to these methods of reducing and plotting the information furnished by the computations, in such manner as shall most conveniently furnish the values of the righting arms for any specified condition lying within the range of the investigation.

The general principles involved in all such graphic methods are entirely familiar to every naval architect and have been long used by him for like problems, and in particular for the usual stability problem where the change of trim is not taken into account. The novelty in the present paper consists chiefly in the application of such methods to the more general problems where change of trim is taken into account, and where the final stability arm is considered with reference to its two components, as noted above.

DISCUSSION.

MR. MAIN: Prof. Leland says there is nothing new under the sun. It has been my own experience sixteen years ago to use a displacement sheet, which I think is

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much in advance and cuts the work down much shorter than Prof. Leland's methods. I would like to ask him what he does in the case of his end ordinates? He says here, "The end ordinates being zero are unaffected by the multipliers." Now, we know as actual shipbuilders that end ordinates are not zero. I have a copy of the sheet here which I would be pleased to leave with the secretary to be entered with the remarks. It gives transverse metacenters, centers, and the binary factor of water line and amidship areas also. That sheet there was probably figured up about fourteen years ago for a very small boat.

MR. LELAND: In answer to the gentleman, if the end ordinates happen to have any value whatever, it is not at all a difficult matter to record one-half the amount of that value and multiply by 2, and in the ordinary form of vessels if the first and last stations are taken at the end perpendiculars there is no appreciable value to the ordinate in most cases, and with reference to the repetition of 3, 5, and 7 I would call attention to the fact it is stipulated in that paper these sheets were prepared specially for classroom use, and it didn't seem to me advisable to complicate the matter.

NOTES ON THE LAUNCHING OF THE CRUISER CHATTANOOGA.

BY MASON S. CHACE, MEMBER.

ABSTRACT.

In launching the *Chattanooga*, the problem which presented itself was to stop the ship without shock, once afloat, before she had moved in the line of the launching ways more than 283 feet; the width of the Staten Island sound opposite the shipyard, from the end of the launching ways to the limit of the water deep enough to float the *Chattanooga* being 575 feet, this vessel having a length on the load water line of 292 feet. Special local conditions made it impracticable to swing the ship around with the tide by the use of stern anchors, for the tide drops two feet before the direction of the current changes. The method employed to check and stop the ship consisted in using a mask secured to the stern at the after edge of the rudder, together with a series of rope stops on each side of the ship, connecting at intervals to bow chains, with two fixed ground chains laid outside the groundways and parallel to them. The stops were arranged to break in sections, starting as soon as the ship was afloat.

The data for the ship, the ways, and the launching are recorded, and the method of lubricating and the arrangement of the mask and rope stops are all carefully given. Considering that the retarding action of the mask is but slight at slow speeds, increasing with the square of the velocity, that it has but little effect when the vessel first enters the water, and that it can be quickly and easily constructed and easily removed after the launch. The mask is recommended by the author to more extensive use. The paper is followed by some valuable drawings with launching data.

This paper was read by Naval Constructor F. S. Smith, in place of the author.

THE CHAIRMAN: It has been proposed that the three papers upon launching shall be read, and the discussion take place upon them all, so that the next paper to be read by Mr. Robinson will be Mr. Groesbeck's.

MR. LEWIS NIXON: There has been a meeting of the council in the other room, and they have decided to recommend to the full body of the society that the price per copy of the first five years' proceedings of the institution be reduced to three dollars a copy, and I therefore make the motion that the recommendation be approved by the full society. (On motion duly made and seconded, it was voted to concur in the recommendation.)

NOTES ON SIDE LAUNCHINGS.

BY ASSISTANT NAVAL CONSTRUCTOR WM. G. GROESBECK, U. S. N., MEMBER.

ABSTRACT.

This paper is written as a supplement to that presented by the author to the society two years ago on the launching of small boats, as this one deals with the larger vessels, viz., the cruiser *Galveston* and the suction dredge *Benyuard*. Details of construction of ways are given on large sheets, and a classified description of the scantlings of the ways is presented for both these vessels. The paper forms a valuable addition to launching data.

THE CHAIRMAN: Professor Peabody will kindly read the next paper.

LAUNCHING OF LARGE MERCHANT VESSELS.

BY WILLIAM A. FAIRBURN, MEMBER.

ABSTRACT.

This paper presents further facts concerning the launching of the *Minnesota*, already described in Paper No. 11. The subject is taken up in detail, and the operation of launching is considered during the three periods of, first, accelerated velocity as the ship starts; second, that of uniform and diminishing speed due to the water; and, third, the condition of buoyancy from the moment when the stern is lifted from its cradle to the time when the hull is completely water-borne. The statics of launching are considered for the three periods. The most important features in launching a vessel are pressure on the fore poppets and the moment of resisting tipping; the two less important ones are the launching velocity and the control of the vessel. Incomplete launching calculations have too often been made in shipyards, and the data obtained and curves drawn are of little value and ofttimes misleading.

Then follows a description of launching ways and the launching data of the *Minnesota*, given in full. The author then presents the launching data of the *Kaiser Wilhelm II.*, the *Kroonland*, the *St. Louis*, *Korea*, and the four large ships built by the Maryland Steel Company, which, all taken together, form a most valuable compilation. Many tables are given to show the effect of moving center of gravity of a vessel, the pressure under the fore poppets for various positions of center of gravity, the result of varying position of the fore poppets, and the effect of lengthening the ground under-water ways upon the moment resisting tipping. The subject is dealt with in a most comprehensive manner, and original tables, which have been compiled on the above-mentioned subjects, are of value for determining launching constants.

THE CHAIRMAN: Gentlemen, these three papers are now before you for discussion.

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DISCUSSION.

MR. SWAN: I would like to make one little addition to Mr. Fairburn's paper. He says that the largest ships that have been built in this country—I suppose he means launched in this connection—are the *Minnesota* and the *Dakota*, and I thought possibly just an outline of the launching data of the *Mongolia* and the *Manchuria*, of the Pacific Mail Company, might be interesting to the society, and appended to the paper. These ships are 600 feet long, 65 feet beam, and about 51 feet molded depth; next to the *Celtic*, I think, the largest ships built in this country. First, the *Mongolia*, launched at Camden on the 25th of July last: Launching weight, including cradle, 9,487 tons, and weight per square foot of sliding ways, 2.48; the weight on the fore poppets, 2,570 tons, and the mean speed of the ship from the time she started to drop from the end of the ways was 7.52 knots; inclination of ways, 11-16 inch; inclination of keel, 9-16 inch. The *Manchuria*, quite recently launched, was in quite a little more further advanced state than the *Mongolia*, and the result was she was quite a little bit heavier. Her weight, including cradle, was 9,937 tons; not very much less than the weight given for the *Minnesota*. Weight on fore poppets, 2,890 tons; mean speed of the ship, 7.11 knots; inclination of the ways, 11-16 inch; inclination of the keel, 10-16 inch. That is, on the second ship there was a slighter inclination, I think, which reduced the amount of backing necessary and helped us out in a number of different ways. Of course, as Mr. Fairburn pointed out in his paper, this results in a considerable increase in the fore poppets, but we found by putting a large amount of soft packing in the neighborhood, about six feet wide, where it came against the ship, and distributing it as much as possible and then shoring up both, the pressure was very considerable. The effect on the ship was not at all bad. In fact, I think she was not damaged in any way.

MR. MAIN: Mr. Chairman, I would like to correct a few misstatements in Mr. Fairburn's paper. He says at the foot of the first page the tipping action invariably leads to serious trouble. I feel he does not speak from experience, although I have no experience myself to contradict this, although I think vessels have been launched from a bank into the water, which had a considerable tipping moment; if I am not mistaken, I think the *Paris* had a tipping moment, and was launched without any serious result. Then, on page 6, he makes some remarks here regarding length of ways, but the *Minnesota* dropped several feet on leaving the ways. On page 9 he gives the tensile strength of the timber there and multiplies the section of the area of one way by 8,000, and he gets a downward force of 145.5 tons. He forgot to multiply by 2, because there were two launching ways for this ship.

If you study these launching curves of the *Minnesota*, which are attached to Mr. Hanscom's paper, you will find the launching curve after the vessel has traveled about 150 feet flattens, but not from reasons mentioned by Mr. Fairburn on top of page 35. The only way we could account for this was the length of the ways in the water was so great we could not get down at low tide to lubricate those ways properly, and when the vessel struck this shortly after starting you can see the effect—it flattened the curve. And as Mr. Fairburn was on board the ship I suppose he felt the slowing but did not know the cause. I had something to do with the launching and followed it very carefully. I think if you refer to the papers, you will find the friction on these ungreased ways was the cause of that slowing down. And then he says, "It is well to note, however, that the vessel was launched two hours after high water." It was two hours after high water should have taken place, but not two hours after actual high water on that day, because we had a strong wind that blew the water up into the river, and it was only ten minutes after mean high water when she went off. But there was mud sticking on the end of the ways, and that showed there was no chance of her getting into this mud. Some of the ways, when she floated out, had mud still sticking on them, and the curves show that she could not have struck the mud, though most of the people thought she struck the mud and that that was what slowed her down.

He talks then of some ways of checking ships here, and seems to think the German method is good. I do not think it is fair to compare that with other methods, because this ship had plenty of water to slide into. The drags only took place, he says, after she began to float, and such devices as that would not suit in a narrow river where vessels have to be checked almost before they touch the water. And he speaks of the methods adopted in the Clyde of burying chains in the ground. I have seen a few launchings on the Clyde, but I have never seen that over there. These drags are usually made of scraps of chain or logs of wood, and so forth, that may be lying around the ways, and as the ship starts to move she takes up one weight after the other, gradually checking her until she come to rest.

MR. SWAN: There is one question I would like to ask Mr. Main, which he can possibly answer, that I noticed in one of these papers, that relating to the *Minnesota*, the launching weight of the ship is given at 10,000 tons, and in another paper it is given at 11,000 tons, and another says the launching draught was determined to a sixteenth of an inch. I think that sixteenth of an inch is a little close on 10,000 tons, and I wish he would set that straight.

MR. MAIN: Mr. Chairman, Mr. Swan is correct there; a sixteenth is very close. The weight was over 10,000 tons. That was the weight proposed at one time, but the launching weight given includes the weight of the moving ways. The poppets, I think, weighed something over 4,000 tons themselves, and the weight of the ship has been added to since Mr. Fairburn got those figures. I think in Mr. Hanscom's paper the draught was something different.

THE CHAIRMAN: If there be no further remarks this discussion will be closed. The chair might remark that it is probably a laudable tendency that, after a first successful launching, the man takes out his feelings of desperation by putting something in writing on paper.

The next paper was read by Mr. Linnard.

NOTES ON THE PERFORMANCE OF THE TORPEDO VESSELS OF THE UNITED STATES NAVY AT SEA.

BY L. H. CHANDLER, LIEUTENANT U. S. N., ASSOCIATE.

ABSTRACT.

It was the expectation of the author to present in this paper the extended results of experiences at sea with

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torpedo vessels of various types belonging to the United States Navy. Due, however, to the fact that the movements of these vessels have not been in accord with earlier expectations, a certain part of the data expected, and, in particular, that covering runs across the Atlantic and *en route* to the Asiatic station, could not be included, and is to be forwarded at a later time. The data presented is put in tabular form and relates to various cruising runs of torpedo boats, either singly or in flotilla, and in various waters of the North Atlantic and West Indies. The items reported relate to the character and length of the run, the condition of the boat, and all items of an engineering character and bearing on the character of the result. Many of the entries are incomplete, due to various difficulties connected with the taking of completed data on all vessels under observation. Sufficient data, however, is presented to indicate clearly the general character of the results which are to be expected from such craft when steaming at moderate speed and under cruising conditions. The supplementary data relating to runs *en route* for the Asiatic station will add greatly to that already presented, and will make of the paper thus supplemented a most valuable collection of information relating to the cruising operations of vessels of this type.

The Chairman: Gentlemen, these are the boats which cost the contractors a great deal more than they got. It is very pleasant to hear anything good of them.

Mr. Baxter: Mr. President, I move that the thanks of this society be extended to the Society of Mechanical Engineers for their courtesy in allowing us to use their rooms during this meeting.

This motion being duly seconded, was put to vote and carried.

The Chairman: Before putting the question on the adjournment, the chair desires to announce that the council has received and accepted the resignation of the secretary and treasurer, Naval Constructor W. L. Capps, now Chief Constructor of the Navy. After careful discussion and consideration of the matter, the council has elected Naval Constructor W. J. Baxter as secretary and treasurer for the coming year.

REAR-ADMIRAL WASHINGTON L. CAPPS, THE NEW CHIEF CONSTRUCTOR OF THE UNITED STATES NAVY.

It is seldom that changes are made in the heads of the engineering departments in the government service, yet within the last few months the chiefs of the two most important constructive branches of the Navy have either resigned or retired. In last month's issue of this magazine was given a sketch of the recently appointed engineer-in-chief of the United States Navy; the following sketch concerns Washington L. Capps, who upon November 1 became the Chief Constructor and Chief of the Bureau of Construction and Repair of the Navy.

Mr. Capps entered the Naval Academy in October, 1880; four years later he was graduated and ordered to the *Tennessee*, the flagship of the North Atlantic squadron, where for two years he served as aide on the staffs of Rear-Admirals Luce and Jouett. He then received the commission of ensign and was ordered to Scotland to attend the school of naval architecture at the University of Glasgow. Two years later, or in 1888, when he received the degree of bachelor of science, he resigned as ensign and was immediately appointed lieutenant, junior grade, and continued his studies, taking a post-graduate course at the university for another year. He then returned to the United States and was assigned to work in the Bureau of Construction and Repair. During the next six years he saw service in the bureau at Washington and New York navy yard and at Cramps' shipyard.

On January 31, 1895, Lieutenant Capps was promoted to the grade of naval constructor, and in December of the same year was ordered to San Francisco, Cal., as superintending naval constructor at the Union Iron Works. During these years he served on various important boards; was a member and secretary of the Stability Board in 1893-1894, which passed upon the whole question of the stability of naval vessels in course of construction and completed. In May, 1898, he was ordered to the Philippines in connection with the fleet under command of Admiral Dewey, and assigned to duty as technical aide on the staff of that officer. It was while on this duty that he planned for and supervised the raising of the sunken Spanish cruisers *Don Juan de Austria, Isle de Cuba,* and *Isle de Luzon.* The following year he was ordered to this country on the *Olympia* and was promoted to the grade of naval constructor with the rank of commander, United States Navy. He was assigned to duty in the Bureau of Construction and Repair and became a member of the Board of Inspection and Survey, continuing this duty until March, 1901, when he became head of the department of Construction and Repair at the New York navy yard, succeeding in that office Rear-Admiral Bowles, who had been appointed chief constructor.

In addition to the various important technical boards upon which he served during the period above mentioned, Naval Constructor Capps assisted Mr. Clement A. Griscom and Rear-Admiral (then Naval Constructor) Bowles in the organization of the *Society of Naval Architects and Marine Engineers* in 1893, and was its first secretary, being succeeded in the office of secretary by Naval Constructor Bowles, and relieving that officer upon the latter's promotion to the grade of chief constructor and chief of the Bureau of Construction and Repair.

The new chief constructor is the youngest rear-admiral in the Navy, and the outlook for his continuing as chief of the Bureau of Construction and Repair for many years to come, following, as it does, many years of such extended and valuable experience, bids most favorably for the carrying out of a definite naval programme and for the establishment of distinctive and effective types of war vessels.

Turbine Transatlantic Steamers.—A new 18-knot steamship to be built for the Union Steamship Company, Limited, New Zealand, is to be fitted with Parsons turbines. Also, the Allan line has placed an order with Workman, Clark and Company, Belfast, for a steamer for its London-Canadian mail and cargo service, of 12,000 tons, 17 knots, to be propelled by twin-screw Parsons turbines.

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THE OIL-BURNING FERRYBOAT RAMONA.

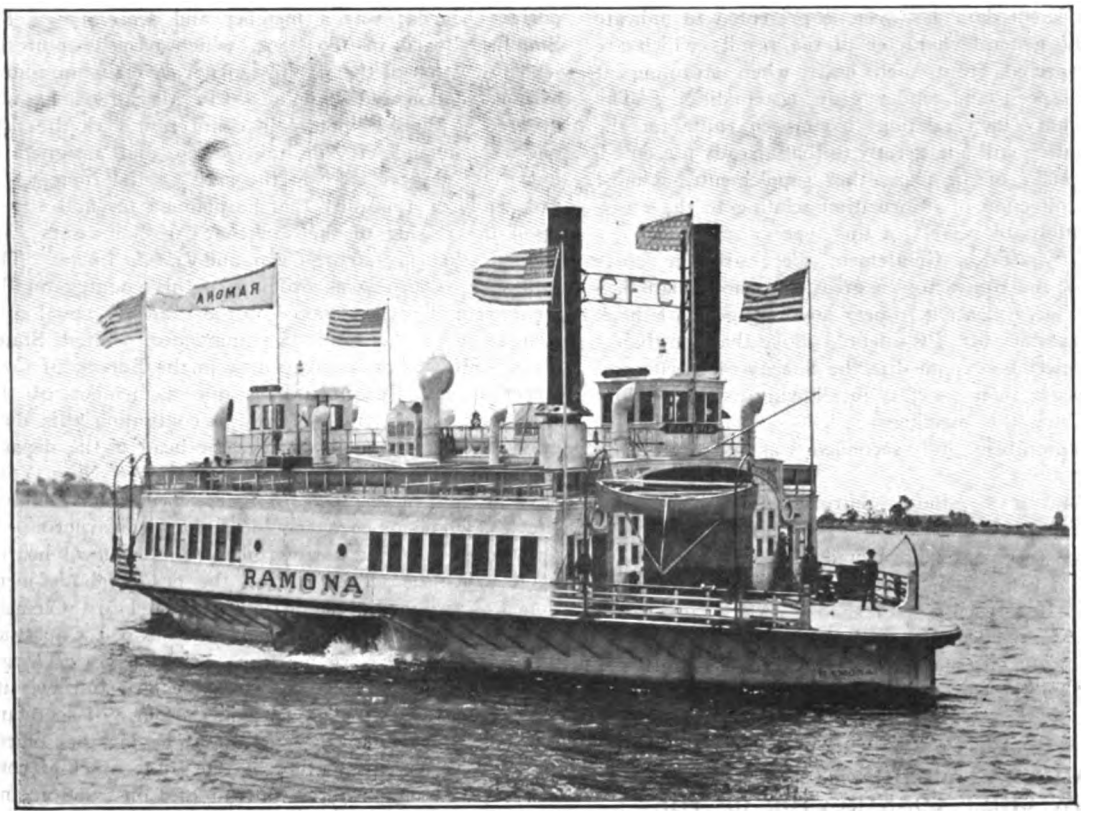
The Risdon Iron Works, of San Francisco, recently completed a fine ferry steamer for the San Diego and Coronado Ferry Company, to be used in the harbor of San Diego.

This vessel is of particular interest for several reasons. In the first place, it is fully equipped with all the auxiliary machinery that usually goes into a regular ocean-going steamer. Also, while the *Ramona* was built for ferry service only, she made the ocean voyage from San Francisco to San Diego, approximately 460 miles, under her own steam. During this trip, which occupied about 53 hours, she was for 24 hours running before a 60-mile-an-hour northwest gale, with heavy and dangerous cross sea, and behaved much better than could possibly have been expected from such a craft. She arrived at her destination in the best of condition and without even as much as a pane of glass broken. On the trip down the coast but one stop was made, and that at Alcatraz landing, where the fuel-oil supply was replenished. For a part of the way she was in tow of the ocean-going tug *Relief*, though using her own engines all the time, the services of the tug being called upon merely to aid the *Ramona* in reaching her destination in time to handle the Fourth of July excursionists that were expected to visit Coronado Beach. She arrived the night before the Fourth, and the next morning was placed in service.

Another point of interest connected with the ferryboat is the oil-burning system, which is comparatively new in design and of especially practical nature. It will be covered in full later on.

The *Ramona* also has the distinction of being the first vessel to use the steam turbine on the Pacific coast. She is equipped with a 10 H. P. De Laval electric light outfit. This generating set attracted much attention and created a most favorable impression on all who saw it in operation.

The *Ramona* is built almost entirely of selected Oregon pine, her dimensions being as follows: length over all, 130 feet; length between perpendiculars, 118 feet; breadth of hull, 29 feet; extreme breadth, 49 feet; and depth to main deck, 13 feet 9 inches. In the center of the vessel, for about 70 feet of her length, there is a broad driveway for horses and vehicles of all kinds. On each side of this driveway there are comfortably furnished, well lighted and ventilated cabins for passengers, all the seats being of highly polished hardwood. From each cabin there is a broad stairway leading to the upper or promenade deck, on the sides of which are numerous and comfortable lounging seats. On this deck are situated the pilot houses, one at each end, and from each of them telegraphic signals and speaking tubes communicate with the engine room.



FERRYBOAT RAMONA, BUILT ON THE PACIFIC COAST, EQUIPPED WITH OIL BURNERS.

The style and arrangement of the motive machinery is rather unusual, the cylinders being placed on an inclined foundation on either side of the vessel, the cranks working in a recess above the main deck and in

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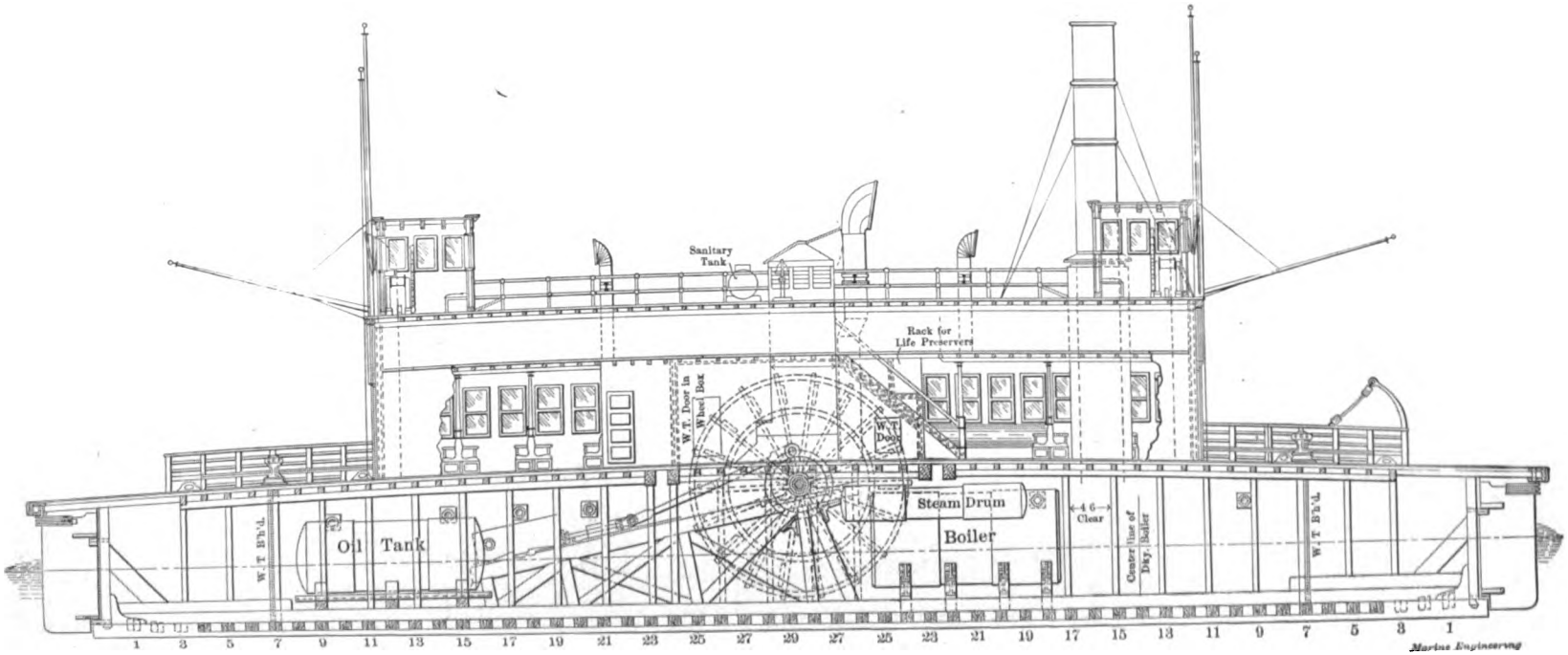
line with the sides of the driveway. There are two high-pressure cylinders, each 20 inches diameter and 72 inches stroke. The working steam pressure is 150 pounds per square inch, and the engines are surface-condensing and work at about 35 revolutions per minute. The indicated horse power is about 670 and the auxiliary machinery indicates about 50 additional horse power. Working at full power the boat can maintain a speed of 12 1-2 knots. There are three 6 and 4 by 6-inch, two 3 and 2 1-2 by 4-inch, and one 3 and 2 by 3-inch duplex Dow steam pumps, all of which are brass fitted and highly finished; there is also one Metropolitan injector and one Dow condenser with air and circulating pump combined. There is one Railton and Campbell patent feed-water filter fitted on the main feed-water line between the feed pumps and the boilers. There are two smokestacks, one on each side of the driveway, and they make an imposing appearance when looking at the vessel end on. The engine and boiler room is entirely below the main deck and is well ventilated by large cowl-top iron ventilators and ample uptakes. Steam is supplied by two boilers of the gunboat type, 7 feet 9 inches diameter and 16 feet long. There is one Fox corrugated furnace in each boiler, 38 inches inside diameter and 7 feet 2 inches long. The tubes are 3 inches inside diameter and 6 feet long, and there are 167 of them in each boiler. Each boiler contains 924 square feet of heating surface. There is one large vertical donkey boiler.

The paddle wheels are 17 feet diameter, built entirely of iron and steel, with the exception of the floats, which are of Oregon pine specially treated with carbolineum. There are 18 floats in each wheel, 6 feet long and 18 inches wide. There are four floats submerged at a time and the depth of the submersion is 12 inches to top of float.

The vessel was built for speed and comfort, and when put into active operation on the regular run between the ferry slips in San Diego harbor she developed more speed than was called for by the owners, so that *one boiler* was found to be quite sufficient to enable the boat to run on schedule time.

Since going into commission she has been running eighteen hours daily under these economical and favorable conditions.

The fuel used is crude petroleum and it is carried in one of two large circular steel tanks that are placed at the opposite end of the hull from the space occupied by the boilers, and right back of the collision bulkhead. The fresh-water supply is carried



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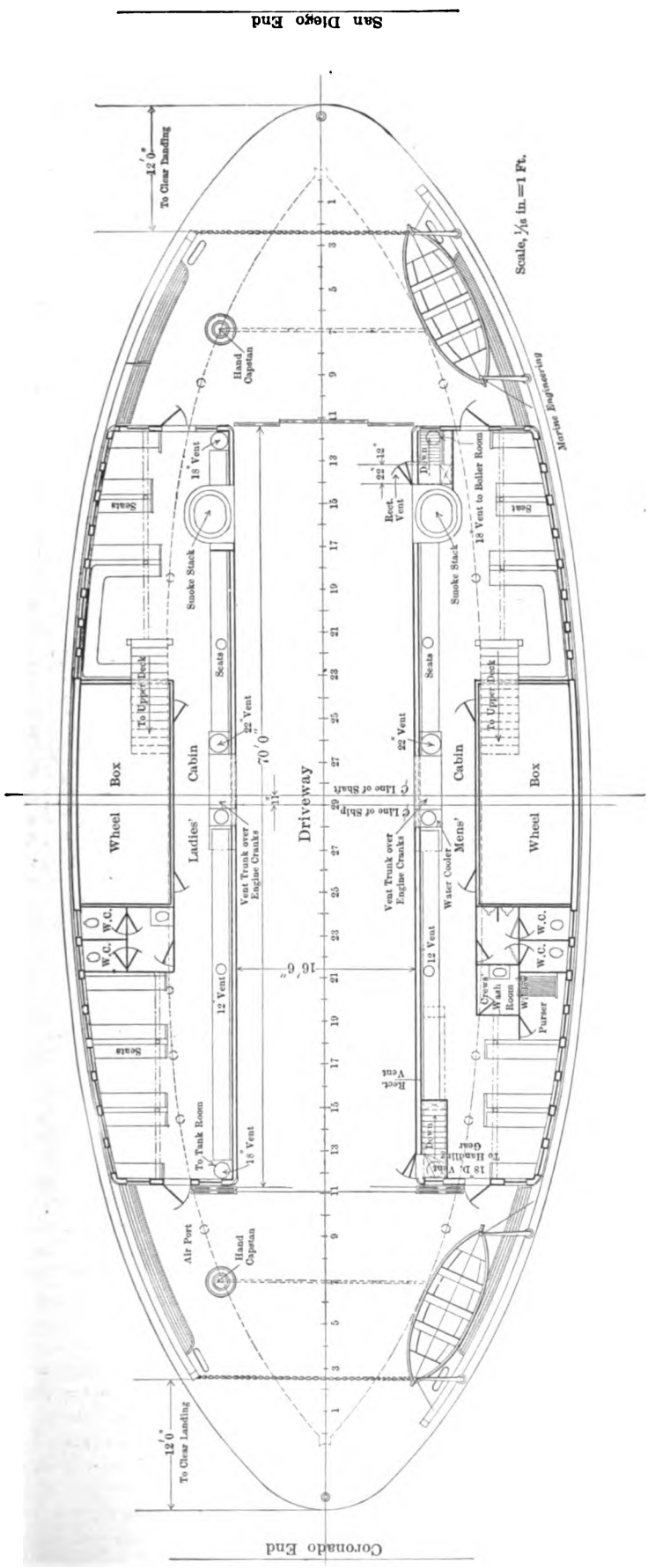

LONGITUDINAL ELEVATION AND DECK PLAN OF OIL-BURNING FERRYBOAT RAMONA.

in the second tank and has ample capacity for carrying sufficient supply for boiler-feed purposes. The space beneath these tanks is lined with heavy sheet lead, and on top of the lead there are placed heavy wooden saddles in which the tanks rest. Heavy iron bands are passed over the top of each tank, and are so spaced that they are fastened down by turn-buckles that lead to ring bolts fastened to the frame of the vessel.

The oil-burning plant is of special design, and was manufactured and installed by the Wright Liquid Fuel System Company, of San Francisco. It proved itself so highly satisfactory in every respect that a full description of it will, no doubt, be interesting reading.

A similar installation, but on a very much larger scale than the plant under discussion, was placed on the steamer *Enterprise*, trading between San Francisco and the Hawaiian Islands.

The system is stated to be entirely different from all the others, and is exceptional inasmuch that a perfect gas is generated by a combination of highly heated oil and steam or air, and that no oil whatever is permitted to enter the furnaces of the boilers. This is considered a very important feature in the line of oil-burning, and is well worthy of the closest attention of all interested in liquid fuel.

The plant under discussion consists of a reverberatory furnace that is bolted on to the head of the boiler; economizers placed in the uptake for the purpose of bustion that eventually passes into the regenerative chambers of the reverberatory furnace; superheaters for the air or steam that is used in combination with the vaporized oil for making the gas; retorts for the purpose of vapaorizing the cold oil; and hydrocarbon burners of a specially powerful and very simple design. In the reverberatory furnace, which the patentees call a "regenerative furnace front," and which is made of heavy cast iron, there is a large circular chamber formed by a metal cone and the walls of the cylindrical portion of the front, and this chamber is designed for the sole purpose of storing and superheating the air for combustion that passes into it from the economizers placed in the uptakes. The cone, which is made of semi-steel, becomes red-hot from the refracted heat in

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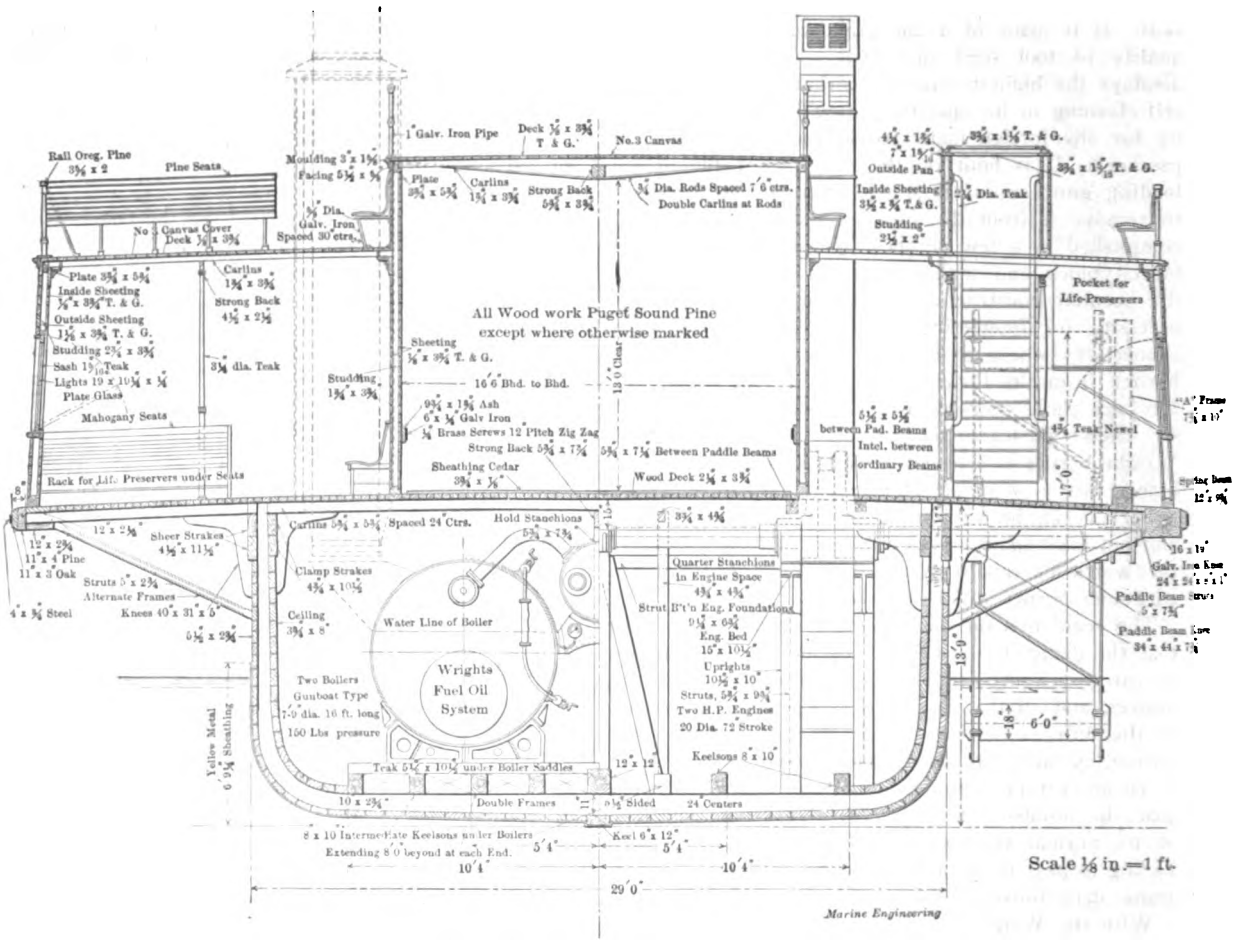
the boiler furnace, and the air confined in the regenerative chamber, after it becomes heated by contact therewith, is discharged through properly proportioned angular holes on to the flame of the gases in the boiler furnace. Perfect combustion is thereby obtained, as will be readily seen by a reference to the photograph of the *Ramona*, taken while the vessel was steaming under full power at full speed.

A system of valves placed in the cylinder of the furnace front controls the distribution of the superheated air for combustion. In the upper portion of the regenerative chamber, entirely separated from contact with the flame, there are placed semi-steel superheaters and bronze retorts. The superheaters are used for heating to very high temperatures the air or steam that in all other oil-burning systems is used for what is commonly called "atomizing," and the retorts are for the purpose of vaporizing the oil; the gases formed by this combination are led into a burner that is inserted a particular distance into the furnace front, and when the lighted torch is applied the ignition takes place right at the tip of the burner and a flame of dazzling whiteness is afterward carried into the boiler furnace. There is no smoke, and, strange to say, there is not the least evidence of carbon in the retort, furnace, or boiler tubes; all are perfectly clean.

There is but one burner placed in each furnace, and it is designed especially for the horse power the furnace is capable of developing; it will therefore be seen that with such an installation it will be a simple matter to get the proper regulation in each furnace and have all the different fires working alike. This in itself is a very great advantage over the systems that require two and more burners in each furnace, because where there is a multiplicity of burners working in the same furnace it is almost an impossibility for the fireman to determine if all of them are doing their work properly; besides, in an oil-burning vessel, where one fireman has to look after from six to eight furnaces, it is a difficult matter to attend to so many burners and get the proper results. There is only one way an oil-burning fireman can regulate his fire, and that is by his eye. If he has but one burner in a furnace, and he knows his business, he can set his fire in a few seconds; but if he is burdened with two or more burners in each furnace, and one or more of them are working badly, he has to lose a great deal of time and patience in trying first one and then the other before he can get perfect combustion and a fire that will do the furnace justice. And where the man has from eighteen to twenty-four burners to look out for under such conditions, and at the same time keep up the required pressure of steam, it will go without saying that the life of the oil-burning fireman will be much harder.



MIDSHIP SECTION OF WOODEN FERRYBOAT RAMONA.

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In the front disk of what the Wright Company calls its "regenerative furnace front" there is a large circular door that works on trunnioned hinges, and through these trunnioned hinges the superheated air or steam and vaporized oil pass from the superheater and retort to the burner. This door is for the purpose of entering the boiler furnace whenever necessary, and, by reason of its working on hinges as described, it can be opened and closed without in any manner interfering with the steam, air, or oil connections. This is a very great convenience indeed.

The burner, while being very simple to operate, is, nevertheless, the result of much study and mechanical skill. It is made of a fine grade of bronze, the best quality of tool steel, and heavy hydraulic pipe. It displays the highest class of workmanship, and, being self-cleaning in its operation, it will be an impossibility for any foreign matter to lodge within its various passages. It is built on the principle of the breech-loading gun; and if it should ever become necessary to remove it from the furnace, the same can be accomplished in a few seconds by simply removing the breech block and withdrawing the tube. Because of the peculiar construction of the breech chamber, the necessity for interfering with the oil, air, or steam connections whenever it is necessary to withdraw the burner from the furnace, is entirely done away with, for once these connections are made up there will be no need whatever to interfere with them. The Wright burner is believed to be the only one that embraces this very simple and important feature. When a burner can be withdrawn from the fire, examined, and put back again at work in less than thirty seconds, the worth of this breech-loading-gun feature of this particular burner will be appreciated.

The regulation on the Wright burner is so very fine that the flame can be held almost at the ignition point or thrown twenty-five feet away, just as the operator desires, and all that is required to govern the passage of the different gases on their way to the tip of the burner, is one little wheel. The whole system seems to be as near perfection as anything can be. It seems that the problem of how to handle crude petroleum at its normal temperature has been solved, without having to pass it through the bulky and, in the eyes of many, dangerous oil-heating tank.

With the Wright system there is no need whatever for the oil-heating tank, with its complex system of thermometers, pressure gauges, relief valves, and gauge glasses, all requiring the closest attention; in its stead there is used the bronze retort that will withstand a pressure of one thousand pounds.

Vessels Lost and Condemned During 1902.—A statistical summary compiled by Lloyd's Register for the vessels of 100 tons and upward totally lost, condemned, etc., during the year 1902, shows that the total for all countries amounted to 233 vessels of 308,182 gross tons. The greatest of the losers were, of course, Great Britain and her colonies, whose losses numbered 101 vessels of about 134,000 tons. Half of these were wrecked, and the rest made up of 3 vessels abandoned at sea, 3 burned, 14 lost in collision, 8 foundered, 12 missing, and one the reason of whose loss is unknown. The next severest loser was Germany, followed by Spain and Norway.

Official Trial of the Cruiser Denver.

On October 22 the U. S. S. *Denver* ran her first official trial over the Cape Ann course, and failed to make the contract speed of 16.5 knots. It will be remembered that the *Denver* and class are a new type of comparatively slow speed and full form with large steaming radius, it being the intention to have them efficient, comfortable cruisers capable of maintaining a speed nearly equal to that under trial conditions.

The *Denver* is 3,200 tons trial displacement; full load displacement, 3,500 tons; length, load water line, 292 feet; extreme length, 208 feet 2 inches; breadth, 44 feet; and mean draft, 15 feet 9 inches. She is fitted with two sets of four-cylinder, triple-expansion engines, 18, 29, 35 1-4, and 35 1-4 inches diameter by 30 inches stroke.

Steam is supplied by 6 Babcock and Wilcox boilers of the regular marine type, giving a total grate surface of 300 square feet and a total heating surface of 13,200 square feet.

The following are some data from the trial:

Average steam pressure at boilers	254 lbs.
I. H. P. per square foot of grate	19.18
Pounds of coal burned per hour	12,200
Pounds of coal per I. H. P. of all machinery	2.1
Pounds per square foot of grate	40.6
Heating surface per I. H. P	2.29
Average temperature in uptakes	685 degrees
Average air pressure in stokehold	.9 inch

The efficiency of the heating surface is well shown by the low ratio of H. S. per I. H. P., and the large amount of coal burned per square foot of grate with such a small draft is practically unequaled.

The trial was conducted under most unfavorable weather conditions, and, after running over the course outward at approximately trial speed, one of the circulating engines broke down and caused a delay of one and one-half hours before the return trip was made. The total collective I. H. P. of the main and auxiliary engines on trial was 5,755. Hand-picked Pocahontas coal was used. Although the trial speed was not reached, it was not because of lack of steam, for the boilers gave most excellent results.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 109 vessels of 43,975 gross tons built in the United States and officially numbered during the month of October, 1903. The largest steel steam vessels included in these figures are 8 vessels which were built on the Lakes and aggregate 35,645 gross tons.

Electricity on the Erie Canal.—Experiments have recently been carried on for determining the value of different systems of electric haulage on canals. A section of about three thousand feet on the Erie canal at Schenectady was equipped with the Wood system, consisting of the duplex mono-rail carried on low poles. A motor runs on this rail and takes current by means of a trolley from a wire above. Four 40-horse-power motors are used to tow the barges by means of a tow line. Other experiments have been made on the Erie canal by F. W. Hawley with motors placed on the boats, supplied from trolley and wire above, and by Mr. R. Lamb, whose motor traveled on an ærial flexible cableway.

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Trial of the Maine's Boilers.

The board appointed to investigate the condition of the *Maine's* Niclausse boilers has completed its test and submitted a report. In general the report is favorable to the boilers, but condemns the arrangement of the evaporators and distillers on board.

The board was composed of Captain J. A. B. Smith, Commander W. B. Badgley, and Lieutenant-Commander W. M. Parke. The test consisted of a run from Hampton Roads to Culebra, Porto Rico, and return. There are twenty-four Niclausse boilers installed on the *Maine*, arranged in three groups. The total grate surface is 1,353.6 square feet; the heating surface, 53,343 square feet; and the indicated horse power, 17,848. Forced draft on a closed fire-room system is provided by 12 Sturtevant blowers.

In addition to the vessel's engineer force of 225 men, 78 experienced men were taken on for the run. The run down, 78.37 hours, was at an average speed of 15.1 knots, and the return, 76.3 hours, at 15.9 knots. No attempt was made to force the fires. The boilers on the run down gave no trouble and there was no difficulty in getting at times 115 revolutions of the main engines. The boilers responded quickly to the varying demands for steam. The coal used going and coming was 1,473-1,528 tons. The average rate of combustion per square foot for the run north was 16.45 pounds, and the average coal per I. H. P. 2.45 pounds—a poor result, due to the use of too many boilers for the number of revolutions.

The board recommends that the distillers be placed higher up in the engine-room hatch, so as to give a rise to the steam pipes from the evaporator, both for the distillers and for the condensers; that new coils for the evaporators, with composition heads instead of cast steel heads, be furnished and fitted; that baffle plates be fitted in the evaporators, and that removable sheet metal casings be provided for the heads of the evaporators in place of the present unsightly canvas covers. It is of the opinion that in future the entire arrangement of the plant on board ship for making fresh water, and also the arrangement of the pumps feeding it to the boilers, must be radically changed, if water-tube boilers of any design are to be a success. Evaporators should not again be crowded into places so hot that men cannot give them the attention they demand, so that there may be no loss of feed water through leaky valves, nor any chance of a suction pipe full of greasy or salty water going into the boilers.

They say: "This problem of providing fresh water, and of keeping fresh water and salt water apart on board ship, is of the very first importance. It is of more importance than the question of what type of boiler to use, for all types of water-tube boilers depend upon the solution of this problem for their existence." They recommend the investigation of the subject by a board. This board could take up the question of the best type of evaporator and distiller for use on board ship, and the question of main condenser, whether two main condensers should be used in each engine room, and the auxiliary condensers dispensed with. Also the best type of grease extractor, and its location in the feed line, and what further precautions should be taken to keep oil out of the feed water. Part of this additional weight might be made up by a reapportionment of the machinery weights, looking to the omission of unnecessary pipes, valves, and fittings. The space required for the rearrangement plant should be insisted upon in all new designs. The board believes that the boilers of the *Maine* are fully equal to the work they were designed to do, and sees no reason why they should not continue to do this work, provided they are given the care necessary for any water-tube boiler.

From the experience with the boilers of the *Maine* on this voyage the board concludes that while clean, fresh water is necessary for the life and efficiency of any water-tube boiler, it is no more a necessity for the Niclausse boiler than for any other boiler of the large-tube variety. Forced draft is unnecessary and undesirable for these boilers as installed in the *Maine*, and the board recommends that forced draft never be used with them, but that any increase of power for the engines should in all cases be obtained by adding to the number of boilers in use. This recommendation is not intended to prohibit the use of the blowers with open fire room, for ventilating purposes. The fire-room ventilators should be carried higher, so as to clear the boats stowed in the cradle. This would give improved natural ventilation for the fire rooms, and would permit the use of the blowers for ventilating without having hot air from the fire-room hatches blown back into the fire rooms. The board's conclusion that forced draft should not be used with the boilers of the *Maine* need not, and does not, apply to the same type of boiler differently proportioned.

It is recommended that one of the boilers in the Stirling Works be set up and tested under a forced draft strong enough to give a rate of combustion higher than will ever be required of them in service. The test will show whether the limit of capacity is likely to be reached under service conditions, the test to be witnessed by a board of officers detailed by the department.

These boilers of the *Maine* are a fine example of mechanical work, and to keep them in proper order will require the services of men of intelligence and mechanical skill. The board was impressed with the obvious fact that the quality of the personnel is of more importance than the quantity. The water-tube boiler calls for more brain work and at the same time less physical effort on the part of the fireman. To get this quality of fireman he will have to be specially trained.

The automatic feed devices were in use, but the board is of the opinion that they cannot be trusted. The removal of this casting would make the feed checks more accessible than they now are. As to the automatic devices for shutting off the water glasses in case of breakage, there is but one feeling about them, and that is a feeling of relief that they are absent.

The board recommends that the lagging be taken off all overhead feed pipes in the fire room. The valves in the fire rooms are conveniently placed, and the steam gauges are plainly visible. The fire rooms are roomy and convenient, and they are fairly well ventilated.

Change of Ownership.—The *American Shipbuilder* of November 12 appears under a change in proprietorship. The paper, which was formerly owned and edited by Bradley and Howell, is now controlled alone by Mr. Howell. New type and better grade of paper give this well-known weekly an improved appearance.

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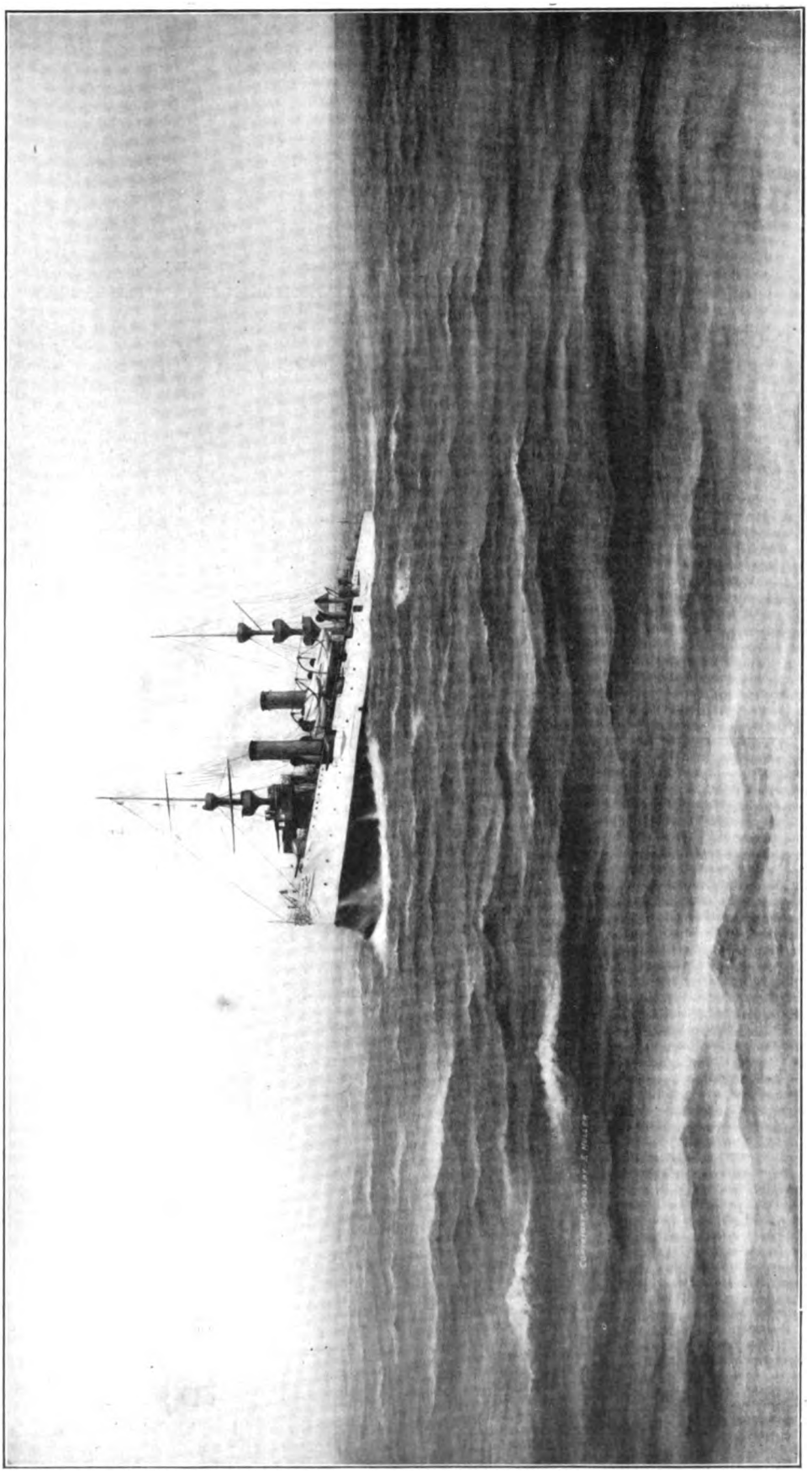

THE UNITED STATES CRUISER NEW ORLEANS IN A HEAVY SEA.

[Photograph Copyright, 1903, by E. Muller.]

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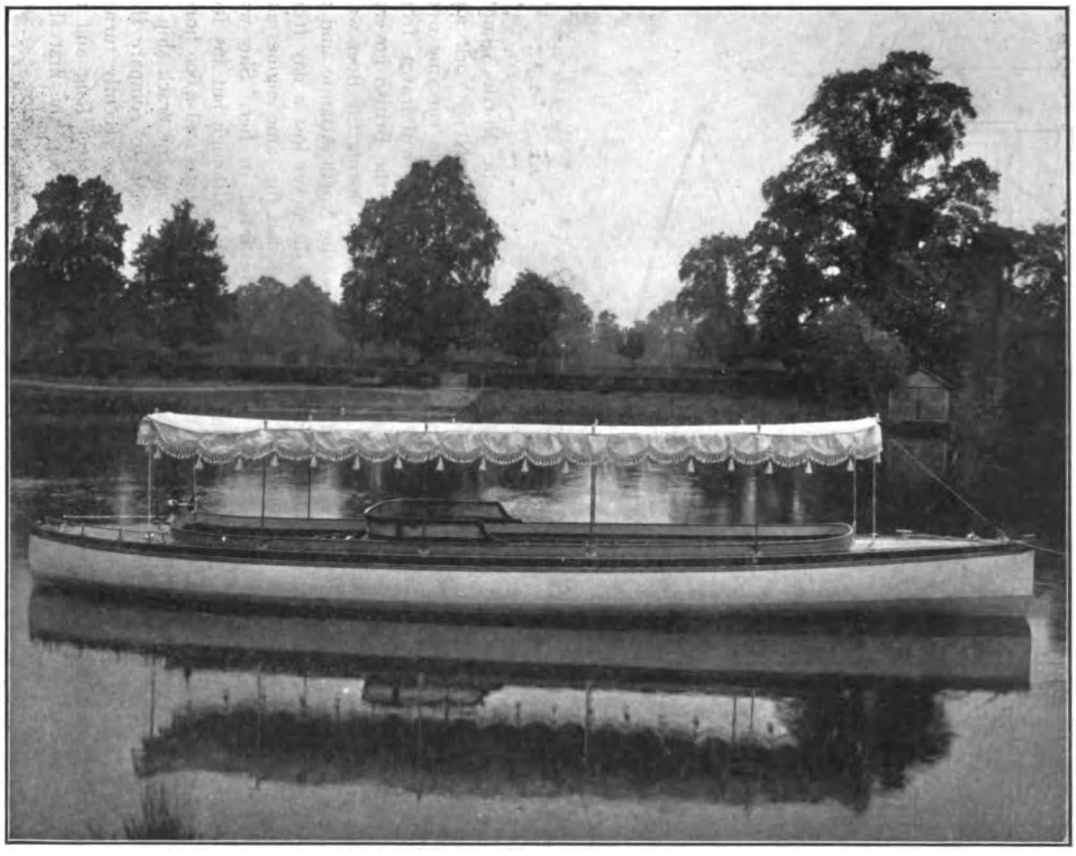

GASOLINE LAUNCH BUILT FOR KING EDWARD VII.

Gasoline Launch for the King of England.

The views presented on these pages are taken of the new launch for His Majesty King Edward VII. built by Tagg and Sons, of East Moulsey. The launch is 32 feet over all, 6 feet beam, and 2 feet 9 inches deep. From the sectional drawings it will be seen the large gasoline tank is placed forward of the water-tight bulkhead. The main body of the launch is finished in teak, handsomely upholstered cushions being provided. Aft of the second water-tight bulkhead a 20 horse-power gasoline engine is placed. The launch is built of teak and cedar and is treble-plated, the outer planks running parallel to the water line, the middle strakes diagonally, and the inner ones transversely across the boat.

The gasoline engine fitted in this launch was built by John I. Thornycroft and Company, Ltd., Chiswick, London, and is of the type used in the Thornycroft steam wagon and several very successful high-speed launches. When running at the normal speed of 900 revolutions it will develop 20 brake horse power. The four cylinders, each 4 inches in diameter by 4 3-8 inches stroke, are all bolted to one aluminum bed plate.

From London *Engineering* the following description is taken:

The engine bearers are cast in one with the top half of the crank chamber or bed plate, so that the bottom half may be removed without disturbing the engine. The keepers to the crank-shaft bearings are not formed in the bottom half of the crank chamber in the usual way, but are quite separate, so that on removing the bottom half the crank shaft is left in position.

The half-speed gear for driving the cam which works the valves, and also the governor, is enclosed in aluminum casings formed in one with the crank chamber. Lubrication is on the splash principle, and the correct amount of oil in the crank chamber is regulated by an overflow pipe.

The cooling water jackets are cast in one with the cylinders, and the water is kept in circulation by what is known as a gear pump, which is driven directly from the crank shaft.

The engine inlet valves are of the automatic type, and governing is effected by throttling the combustible mixture. The handle for starting the engine on first going off is connected to the crank shaft by a chain and ratchet wheel. The two forward exhaust valves have an attachment by which they may be kept open until the engine has got to work, thus relieving the compression on these two cylinders and making starting easier.

A Stethnos carburetor is adopted, gasoline being supplied to it from a small tank, holding one gallon, situated near the engine. The main gasoline supply tank is right forward and has a capacity of 16 gallons; and the two tanks are connected by a copper pipe enclosed in a lead pipe, so as to minimize the chance of leakage. The gasoline is pumped by hand from the large to the small tank. The latter stands in a metal tray, which is drained overboard by a pipe, so that any

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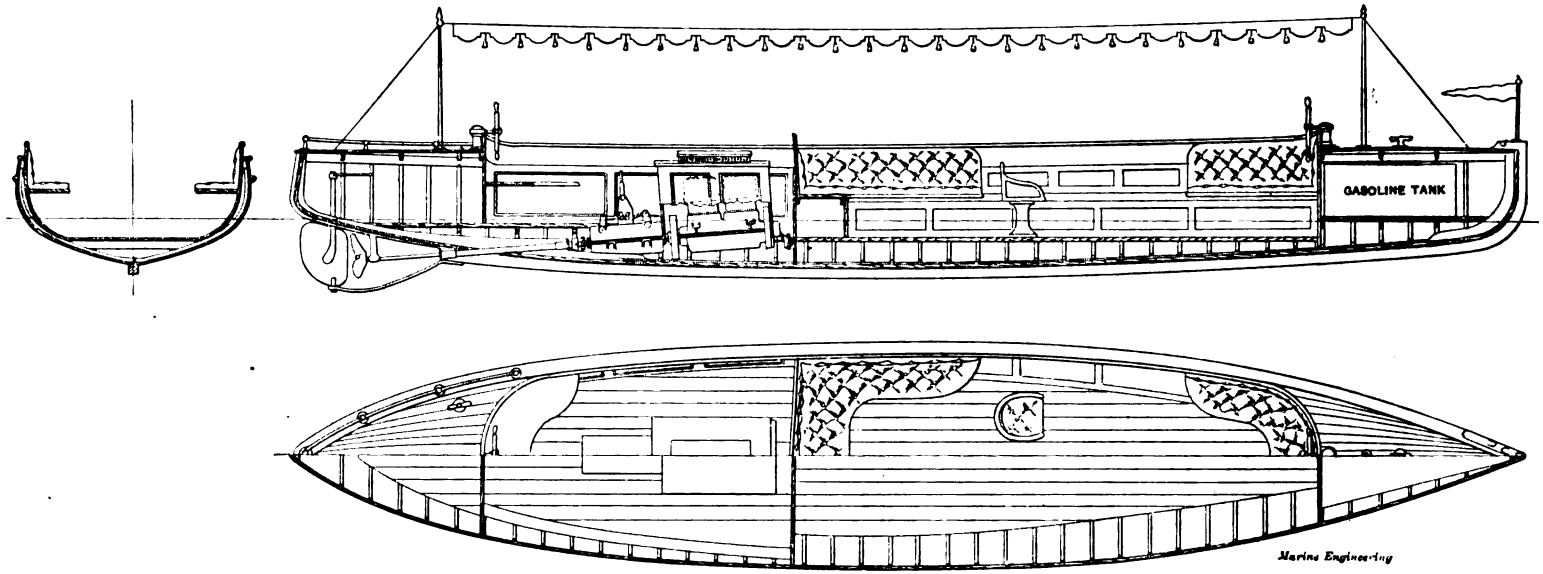

SECTIONAL ELEVATION AND DECK PLANS OF GASOLINE LAUNCH FOR KING EDWARD VII.

leakage which might occur would be instantly conveyed away; the carburetor also stands over a tray.

The exhaust pipes are water-jacketed, resulting in the cooling of the gases and making the exhaust more silent.

The speed of the boat, with the engine running at normal revolutions—that is, about 900 revolutions per minute—is about 10 miles per hour; but the engine may be accelerated up to 1,300 revolutions, which will give a speed of about 13 miles per hour. The ignition is on the high-tension principle, current being supplied from two secondary batteries. De Dion pattern sparking plugs are used. External spark pumps are fitted, and, these being always in view, the driver can tell at a glance whether the sparking mechanism is in working order. The tank capacity of this boat is 17 gallons, and it has been found by careful experiment that the engine consumes 1 pound of gasoline per brake horse-power-hour. Therefore, when traveling at the rate of 10 miles per hour, the engine developing 20 horse power, 20 pounds (approximately 2 1-2 gallons) of gasoline will be consumed at the end of 10 miles—that is to say, the tanks are of sufficient capacity to carry the boat somewhat over 60 miles. It may here be interesting to compare the weight with a steam engine and boiler of equal power with this engine. The weight of the gasoline engine complete, with reversing gear, batteries, etc., and gasoline sufficient to take the boat 60 miles, is very nearly 500 pounds. A 20 brake horse-power double-acting condensing steam engine and boiler complete would weigh about 2 tons, and coal and water sufficient to last for 60 miles would amount to about 2,500 pounds, making a total of 7,000 pounds, or fourteen times the weight of the gasoline engine and fuel.

The Britannic to be Broken Up.—The famous old ship *Britannic*, of the White Star Line, which has seen continuous service from 1874 to 1899 on the North Atlantic, is now in Bremen, where it is reported she will be broken up for junk. While in the North Atlantic she made 260 round trips between New York and Liverpool, traversing 1,800,000 miles and carrying over 200,000 passengers. When she was withdrawn from the line it was to carry troops for the British government to the south coast of Africa during the Boer war. During her entire service on the North Atlantic, and as a transport, it is stated that she never lost a day from accident or disability, and now has the same engines and boilers that were originally fitted in her. She was built by Harland and Wolff, and, although but 465 feet long, 45 feet beam, of about 5,000 tons and 4,600 horse power, she was in her day considered the crack ship of the North Atlantic. It is interesting to compare this old-timer with the *Cedric*, which was recently turned out from the same yard and is 700 feet long and of 21,000 tons registry. The *Britannic* was the first ship that crossed in less than eight days and made a record for eastward passages of 7 days 16 hours.

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MERCHANT AND GOVERNMENT.

Name.	Capital.	Men.	Ships building July 1, 1903		Government vessels building		Merchant capacity.	
			Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.
The Neafie and Levy Ship and Engine Building Co., Philadelphia.	800 000	1.400	10	1.949	2	12 900	15	8,000
Burlee Dry-Dock Co., Port Richmond, Staten Island	.....	900	7	6.140	2	1,298	..	.
Bath Iron Works, Bath, Me	.....	....	3	900	2	18 148	..	.....
Harlan and Hollingsworth Co., Wilmington, Del		2.000	6	9.741	1	340	..	.. ...
Crescent Shipyard, Elizabethport, N. J.*	.....	850	3	3 545	3	3,548	15	10,000
Fore River Ship and Engine Co , Quincy, Mass	6,250 000	4 000	7	17 339	4	49 096	10	45.000
New York Shipbuilding Co., Camden. N. J	10 000,000	4,200	3	30,000	2	30.500	6	30 000
Shipowners' Dry-Dock Co., Chicago, Ill	800,000	200	1	352	1	140	..	10,000
Jenks Shipbuilding Co , Port Huron, Mich	150,000	450	1	4,700	1	718	4	10,000
Townsend-Downey Shipbuilding Co., Shooter Island, N. Y	.....	1,200	4	.....	1	626	6	20 000
Total	18,000 000	15 200	45	74,666	19	117 294	56	133,000

* Also building two small Mexican war vessels.

MERCHANT ONLY.

Maryland Steel Co., Sparrow's Point, Md	3,000,000	2,000	3	8.697	..	.....	..	40,000
Merrill-Stevens Engineering Co., Jacksonville, Fla	250 000	200	1	900	..	.....	6	1.500
Risdon Iron and Locomotive Works, San Francisco	.....	.	1	300	..	.....	..	.....
Perth Amboy Shipbuilding and Engineering Co , Perth Amboy, N. J.	500 000	200	1	2.242	..	.....	15	.....
Eastern Shipbuilding Co., New London, Conn	.	1.800	2	42,000	..	.....	..	.....
Delaware River Iron Shipbuilding and Engine Works, Chester, Pa.	.....	1,500	4	17,450	..	.....	6	6.000
T. S. Marvel and Co., Newburg, N. Y	150.000	400	1	400	..	.....	4	5 000
Total	3,900,000	6,100	13	71.989	..	.....	31	52,500

GOVERNMENT ONLY

Union Iron Works, San Francisco	.....	....	..	.....	5	52,700	..	.....
Gas Engine and Power Co., and Chas. L. Seabury and Co., Morris Heights, N Y	.....	....	..	.....	2	2,170	..	....
Iowa Iron Works, Dubuque, Iowa	150,000	200	..	.....	1	350	..	.....
Geo. Lawley and Son, Corp., South Boston, Mass	.....	....	..	.....	1	166	..	.....
Wolff and Zwicker Iron Works, Portland, Oreg	.....	....	..	.....	1	248	..	.....
Spedden Shipbuilding Co., Baltimore, Md	150,000	300	..	.....	1	108	2	9.000
Baltimore Shipbuilding and Dry-Dock Co , Baltimore	750,000	500	..	.....	3	1.565	4	8,000
Moran Bros Co., Seattle, Wash	2,000,000	1,200	..	.....	1	14.948	..	.....
Newport News Shipbuilding and Dry-Dock Co., Newport News	.....	6.500	..	.....	7	96.238	10	50,000
Wm. Cramp and Sons' Ship and Engine Building Co., Philadelphia.	15.531,000	8.000	..	.....	4	*45.160	5	45,000
Wm. R. Trigg Co., Richmond, Va	.....	....	..	.....	2	†3.200	..	.....
Total	18,581,000	16,700	..	.....	28	216 853	21	112,000

* Turkish war vessel building included.
† Tonnage of one not given.

GREAT LAKES.

American Shipbuilding Co., Cleveland, O., and branches	.....	8,000	26	97.520	..	.....	*40	†145.000
Craig Shipbuilding Co., Toledo, Ohio	1,250,000	452	4	11,500	..	.....	7	20,000
Total	1,250,000	8.452	30	109,020	..	.....	47	165 000

* Men not returned by West Bay City.
† Tonnage not returned by West Bay City or Chicago.

SUMMARY.

Merchant and Government	18,000,000	15.200	45	74,666	19	117,294	56	133.000
Merchant only	3.900,000	6,100	13	71,989	..	.....	31	52 500
Government only	18,581 000	16.700	..	.....	28	216,853	21	112,000
Great Lakes	1,250.000	8.452	30	109,020	..	.....	47	165,000
No construction	1,450 000	800	..	.....	..	.....	22	67,000
Total	43,181,000	47,252	88	255 675	47	334,147	177	529,500

Contract price of government construction, $88,229,460.

TABLES FROM THE COMMISSIONER OF NAVIGATION'S REPORT, GIVING THE SHIPBUILDING IN THE UNITED STATES FOR THE PAST YEAR.

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ANNUAL REPORT COMMISSIONER OF NAVIGATION.

The outlook for the coming year for shipbuilding is not in the least encouraging, according to the report of Mr. E. T. Chamberlain, commissioner of navigation, Department of Commerce and Labor. In the last annual report it was stated: "New vessels have not been ordered to take the place on the ways of large ocean steamers which have been launched, have been completed, or are nearing completion." The conditions have little changed since the time that report was written, and but five large steamers, of which four have been launched, remain unfinished. Because of lack of work the force of men in practically all the yards is being cut down, and if present conditions continue it is probable that within a few months the yards on the seaboard will be working at less than half their capacity.

From the reports received of different shipyards the tables on preceding page are given.

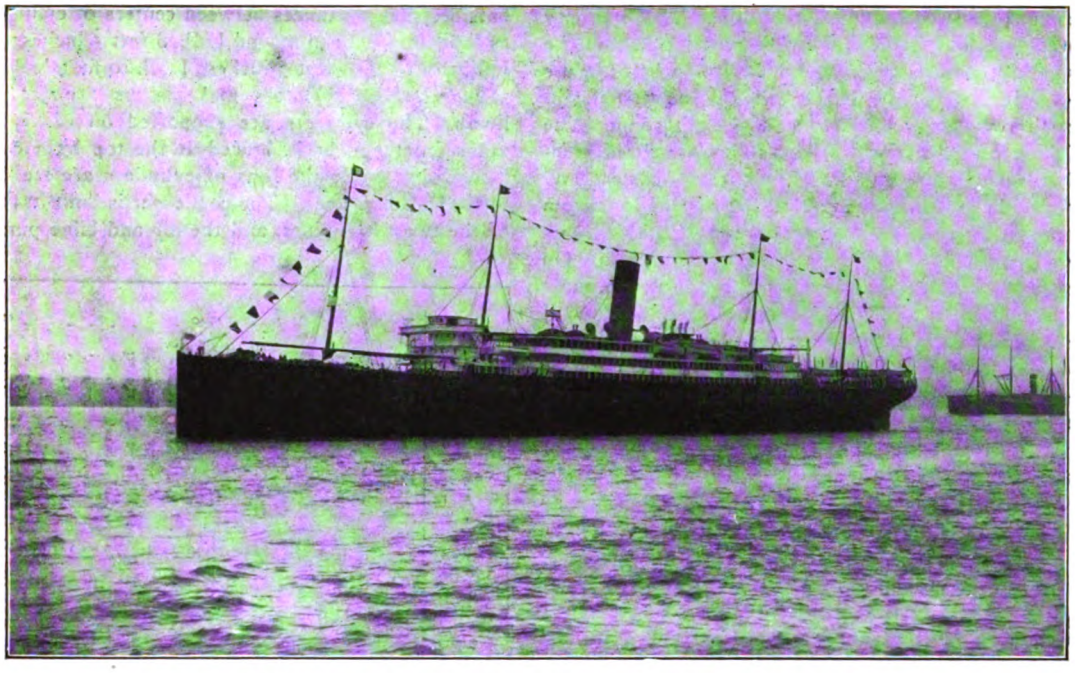
The total number of vessels in net tonnage, including government and merchant, in the last four fiscal years is as follows: 1900, 115 vessels, 391,009 tons; 1901, 160 vessels, 636,793 tons; 1902, 171 vessels, 617,376 tons; 1903, 135 vessels, 589,822 tons.

The names of the five unfinished deep-sea ships are as follows: *Missouri,* for the International Mercantile Marine Company, building at Sparrow's Point, Maryland, and of 7,914 gross tons. The *Minnesota* and *Dakota,* of the Great Northern Steamship Company, for the transpacific trade, of 21,000 tons, are building at New London, Conn. The *Dakota* has not been launched. The *Mongolia* and *Manchuria,* for the Pacific Mail Steamship Company's transpacific and Hawaiian service, are building at Camden, N. J., and each is of 13,500 tons gross tonnage.

STEAMSHIP ARABIC, OF THE WHITE STAR LINE.

The White Star Line has added to its service of steamers, sailing on Wednesday from Liverpool and Friday from New York, the new steamship *Arabic,* recently turned out of the Harland and Wolff yards at Belfast, Ireland. This ship was ordered by the Atlantic Transport Line, but after the merger of the steamship companies the passenger arrangements of the vessel were changed to meet the requirements of the White Star Line service, to which line the vessel was transferred.

The *Arabic* resembles in general the steamships *Cedric, Celtic,* and *Cymric,* though she is somewhat smaller than the first two named vessels, the length between perpendiculars being 600 feet, and the beam over all 68 feet. The other dimensions will be found in the accompanying table. The greatest difference between this ship and those of the Atlantic Transport Line is that there are no cattle carried, the space on the main deck being entirely devoted to third-class passenger accommodations, and it is in this respect that this ship attracts special attention.



PASSENGER AND CARGO STEAMSHIP ARABIC OF THE WHITE STAR LINE.

There are five complete steel decks—orlop, lower, main, upper, and spar deck, the spar deck being the weather deck from stem to stern. The windlass and engine are mounted on the spar deck forward; directly aft of them is hatch No. 1; foremast; hatch No. 2 and hatch No. 3; then comes the officers' deck house, similar to that on the *Cedric;* the mainmast; hatch No. 4 and the main deck house. Each hatch is served by two winches and booms attached to the mast, or, in the case of hatch No. 3, booms are stepped on the deck at the forward side of the officers' house. This house is three decks and contains quarters for captain and officers, chart room, and above all a flying bridge with steel

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screen amidships, behind which are placed the engine room and deck telegraphs, binnacle, and steering wheel. The chart room is directly aft of this screen.

On top of the main deck house is the ship's compass, set up high above deck, as will be seen in the engraving. The main house has two complete decks; on the upper promenade deck, at the forward end, is a large writing room with hard-wood floor and several mahogany writing tables and upholstered lounges. It is pleasantly lighted from a skylight above and also through square ports at front and sides; it is entered from the main hallway at the forward end of boiler-room casing; the passageway on the port side leads aft to the large first-class smoking room, which is well lighted from ports and skylights and is finished in mahogany. Fine deck space is provided on both sides, although there are three lifeboats swung along each after side of the deck from ordinary type of davits. Descending the main stairway we come to the promenade deck below. This stairway and entrance hall is finished in quartered oak, and the floor and treads are covered with large blocks of white rubber tiling. Forward of the hallway are several single-berth rooms and large toilet and bath room. The furnishing of the first-class rooms throughout is practically the same, and consists of mahogany bedstead and cabinet with large mahogany clothes press and transom seat which, in most cases, can be used as a third bed. In several of the rooms the upper berth folds up. On either side of boiler casing, running aft from the main hall, is a passage along which opens a single row of state rooms. These rooms are all practically 8 feet wide by 10 feet long, with plenty of head room and square ports with ventilator tops. The finish is white enamel paint, which, with the furnishings, make them simple but very attractive and airy. The barber shop and bar are at the after end of the house.

Descending to the main deck, the stairs land in an entryway which opens into the first-class dining saloon, fitted with three fore-and-aft tables, and short tables on either side. The dining room is lighted through large side ports and through a crystal dome in the center. The coloring of this dome is yellow and gold and transmits a most pleasing light. On the port side, aft the dining room, is the large first-class pantry, aft of which are the galleys.

On the port side is a gangway leading to the engineer's quarters and engine room, while on the starboard side are the first-class state rooms. Other state rooms of the first cabin are found at the forward end of the dining saloon. The second cabins, which are directly aft of the first cabin, are very comfortably fitted. A large dining saloon is on the upper deck, and smoking and reading rooms in the deck house above. The total accommodation for first-cabin passengers is 350 and for second-cabin is 200.

As previously stated, the third-cabin quarters are of special interest, extending practically the full length of the ship. Most of the berths are arranged in two-, three-, and four-berth rooms, fitted with mattresses, sheets and blankets, washstands, etc. A large dining room is located amidships, with tables and separate chairs. Fresh air is supplied for main cabin and passageway by a complete system of mechanical ventilation, consisting of air ducts and Sirocco fans.

Between the two deck houses is a large hatch, and the after holds are reached by three other hatches. At the stern are a steering-wheel house and warping capstan. The steering gear is of the Wilson and Pirrie type, consisting of two duplicate sets of heavy double-inverted, direct-connected engines mounted parallel to each other and to the keel. One set is always held in reserve and can be geared to the quadrant by moving it on its foundation. A telemotor controls the valves, which are of the piston type.

The general appearance of the engine room is similar to that of other ships turned out by this famous yard at Belfast. There are two sets of four-cylinder, quadruple-expansion engines, the arrangement of the cylinders being best suited to reduce vibration. From forward aft the order of cylinders is: high-pressure, second intermediate, low-pressure, first intermediate. The valves of the adjoining pairs of cylinders are on the outside. The distances between centers of cylinders are as follows: H. P. to second I. P., 8 feet 5 inches; second I. P. to L. P., 14 feet 3 inches; L. P. to first I. P., 8 feet 5 inches. All cylinders and pistons are fitted with liners. The cylinders are supported on cast-iron columns front and back, braced at the top by a cast-iron box girder, while the tops of cylinders are steadied by wrought-iron braces. The condenser is built in the back of the two aft engines, and the air and bilge pumps are

Name—Arabic. Nationality—British. Type—Passenger and freight.
Launched—1903. Builder—Harland and Wolff. Owner—White Star Line.

Length between perps	600 ft.
Breadth	65 "
Depth	44 "
Gross tonnage	15,300 tons
Cargo capacity	16,500 "
Load draft	33 ft. 1 in.
Displacement	26,500 tons
Engines: Number	2
Type	four-cylinder quadruple
Cylinders, diameters	30, 43, 63, and 89 ins.
Stroke	5 ft.
I. H. P. at sea	10,080
Revolutions at sea	79
Boiler pressure	214 lbs.
Shafting, crank	18 ins.
" line	17
" thrust	17 3-4, 28 1-4 "
" propeller, mean	18 1-2 "
Propellers	two, 3 blades each
Diameter	18 ft. 6 ins.
Pitch	23 " 6 "
Area, developed, each wheel	84 3-4 sq. ft.

Boilers, Scotch	4 single end, 4 double-end
Diameter	14 ft. 5 ins.
Length	single-end, 11 ft. 10 "
	double-end, 19 " 10 "
Tubes, diam	3 1-2 "
" number, single-end, 370; double-end, 740	
" length over all, single-end, 7 ft. 6 ins.	
	double end, 7 " 11 "
Furnaces, mean diam	42 "
" number each	single-end, 3
	double-end, 6
Length of grates	5 ft.
Howden forced draft.	
H. S., each	single-end, 2,169 sq. "
	double-end, about 2,200 " "
" " total, about	26,370 " "
G. S., each	single-end, 52 " "
	double-end, 104 " "
G. S. total	644 " "
H. S. ÷ G. S.	40.8
I. H. P. ÷ G. S.	15.3
H. S. ÷ I. H. P.	2.63

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operated from links taken from the first intermediate crosshead.

Dimensions of the cylinders are as follows: high-pressure, 30 inches; first intermediate-pressure, 43 inches; second intermediate, 63 inches; low-pressure, 89 inches; common stroke of 5 feet. The length of connecting rods between centers is 8 feet. The thrust is taken up by eight collars of the horseshoe type between the rings of the thrust shaft; the outside of the latter over the collars is 28 1-4 inches, the diameter between collars is 17 3-4 inches. The line shaft is in seven lengths and 17 inches in diameter. Propeller shaft is 18 1-4 inches at the after end and 18 3-4 inches at the forward end, and fitted with a brass sleeve in several lengths.

Weir pumps are installed at the forward end of the engine room; there are also an auxiliary condenser, two evaporators, and distiller. The usual outfit of bilge, water, sanitary, fire service, etc., pumps are installed. In a recess in the bulkhead above the thrust shafts is the dynamo room, in which are placed three sets of Allen compound engines direct-connected to generators running at 256 revolutions; the voltage is 100, and 600 amperes. A closed feed-water heater is placed in the upper engine room.

The boiler equipment consists of four double-end and four single-end Scotch boilers fitted with Howden forced draft. They are placed in two stokeholes, the four double-end boilers being mounted abreast of each other and aft of the single-end boilers. The coal is carried in athwartship bunkers. The diameter of the boilers is 14 feet 5 inches, the length of the single-end 11 feet 10 inches, and the double-end 19 feet 10 inches. There are three furnaces in each single-end boiler and six furnaces in each double-end boiler, each furnace having its separate combustion chamber. There are 128 tubes in the center nest and 121 in each of the wings; all tubes of the single-end boilers are 7 feet 6 inches and those of the double-end 7 feet 11 inches long, outside diameter 2 1-2 inches. The mean diameter of the Morison furnace is 42 inches; the length of grates is 5 feet. The propellers are of steel with three manganese-bronze blades.

Saving Overprinted Blueprints.

The following simple method of saving burnt blueprints and prints made on old paper appeared in the *American Machinist:*

"The process, if it can be so called, depends on the fact that a print which is washed but a very little, say about half a minute, or just enough to bring out the blue, will, if exposed to sunlight while wet, bleach out, and that in a very few minutes. By watching it the lines can be brought out white and clear while the blue ground is not sensibly affected. After the lines have been brought out to the desired clearness, put the print back in the water and wash it as a properly exposed print would be.

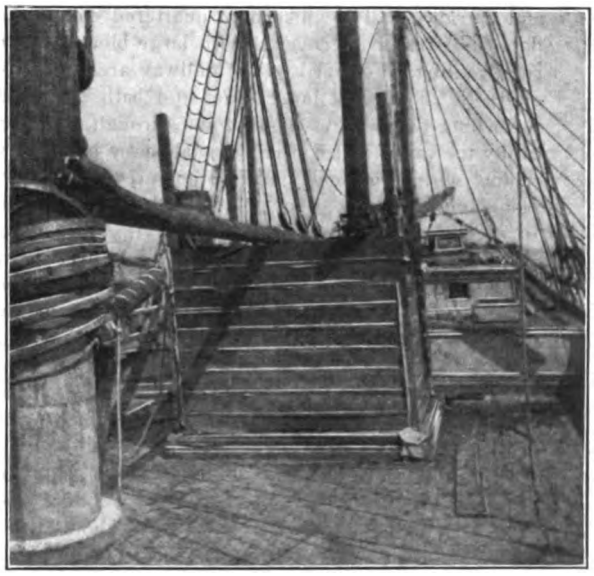
"This method is particularly handy for prints on old paper, as it sometimes happens that a print is wanted, but no paper is at hand except some that will not make a readable print. By printing the old paper about the same as if it were fresh and then bleaching in sunlight a very fair print can be secured.

"J. J. EWING."

The Ill-fated Cactus.

A correspondent sends us the accompanying deck view of the American schooner *Cactus,* which ran ashore on the upper Washwoman Reef on the coast of Florida. The schooner was loaded with coal bound for Key West. Considerable sea was running at the time and twelve hours after stranding the vessel was rapidly filling; a tug came to her assistance, but the water was too rough to allow coming alongside. For a month the *Cactus* remained ashore, favored by calm weather, and was then sold with her cargo for $580. Her purchaser went to the wreck and, after a month's work, pumped the vessel out and towed her to Key West, where he sold her for $8,000.

Temporary repairs were made by hauling the *Cactus* out on a marine railway, and she set sail for Jacksonville for permanent repairs about the first of March.



COFFERDAM OVER HATCH FOR RAISING THE CACTUS.

About sixty miles from Key West she started to leak so badly that the captain brought her about and headed for Key West again, while the crew pumped night and day to keep her afloat. Two hours after she reached harbor she sank in 38 feet of water with a list of 45 degrees, leaving her weather rails just above water.

The work of raising the *Cactus* was much more difficult than at the previous time. The contractor took a scow alongside the schooner and built a cofferdam the same size as the midship hatch, 12 by 8 feet. The cofferdam was built of posts 4 by 4 inches and sided with 1 1-2 by 12-inch planks battened with canvas. The posts were 2 feet longer at the bottom than the planking, so that they would go down inside of the hatch. A beam was lashed from the mainmast to the mizzenmast, and from this with blocks and fall the cofferdam was hoisted up and lowered down into the hatch and a diver battened it to the deck. The *Cactus* was then pumped out in ten hours with a 6-inch centrifugal pump and taken to the railway for repairs. A month later she sailed for Mobile, Ala.

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BOILER DESIGN.

BY H. K. SPENCER, U. S. R. C. S.

The power necessary to drive a hull of given size and form at a given speed having been determined by one of the usual methods, the next consideration is the type of machinery to be used in producing that power. It does not follow that because a certain type of engine is most economical in the consumption of steam and fuel that it is always the best one to install, and that it will prove the most economical when all the conditions of the problem are considered. Interest on the cost of the installation is always an item; the cost of fuel and the cost and quality of labor are also considerations.

Where fuel is cheap and labor not only cheap but poor, machinery of the simplest type should be selected, as it is not only the best under the conditions, but the cheapest in the long run, as the interest on the higher-priced machinery and its rapid deterioration under cheap and poor attendance would more than outweigh any considerations of fuel economy. The commercial considerations are really the governing ones, and cannot be ignored to secure any of the many economies which can be obtained by the expenditure of money. For a vessel that is to make long voyages, the quantity of fuel that must be carried will be a considerable part of the total carrying capacity of the vessel; and as the cost of carrying fuel to the exclusion of cargo has an important bearing on the profits of the voyage, the selection in this case would be machinery of high economy. For any vessel, in whatever service, positive certainty of continuous running is an essential in the machinery.

The weight of the machinery itself must be considered. It has been determined that a certain power will be required to drive a given ship at a given speed; steam pressure and the degree of expansion to be used have been fixed upon, and, with these fixed, the necessary power can only be obtained with a certain piston displacement, which means either a large slow-running engine, a small fast-running engine, or a compromise between the two.

To illustrate, an engine such as is used in torpedo boats, to develop on trial 1,800 I. H. P., would have a piston speed of about 1,200 feet per minute, and the mean effective pressure referred to the low-pressure cylinder would be about 46 pounds. The diameter of the low-pressure cylinder must then be 37 inches, or if divided into two cylinders, as is usual, then each will be 26 inches in diameter, and would be given a stroke of 18 inches, which would make the engine run at a rotative speed of 400 revolutions per minute. An engine in a merchant steamer developing the same power would be run at a piston speed of about 700 feet per minute, which, with an equivalent mean effective pressure of 35 pounds referred to the low-pressure cylinder, would require a cylinder 56.5 inches in diameter; it would be given a stroke of 42 inches, which would make the engine run at 100 revolutions per minute.

The engine with a piston speed of 700 feet per minute would weigh about 175 pounds per I. H. P., while the torpedo-boat engine would weigh about 25 pounds per I. H. P., which makes the ratio 7 to 1. Scotch boilers worked with natural draft would weigh something like 200 pounds per I. H. P., with moderate forced draft about 150 pounds per I. H. P.; water-tube boilers under natural draft about 120 pounds per I. H. P., with moderate forced draft about 85 pounds, and with an air pressure of 4 or 5 inches of water, such as is used in torpedo boats, about 28 pounds per I. H. P.

The allowable draft of the vessel often limits the weight of machinery. When the vessel is to run in shallow water and screw propellers are to be used, the light, quick-running engine must be adopted. For ordinary service the engine of moderate piston and rotative speeds should be selected from considerations of durability, minimum repairs, etc. Without the use of water-tube boilers, it cannot be said that the use of quadruple-expansion engines makes a saving in the total weight of machinery, because of the increase in weight caused by the heavier boilers necessary for the increased pressures which are essential to the economical working of such engines.

The comparative economy of quadruple, triple, compound, and simple engines is well known, and, having decided to what extent it is advisable to carry fuel economy, the selection of the type of engine can be made. Suppose that in a certain case 1,800 I. H. P. is required, and that it has been decided best to use an ordinary three-cylinder triple expansion engine with moderate piston speed, and that the boilers are to be the Scotch type worked under natural draft and built for a working pressure of 160 pounds per square inch.

It can be assumed that the engine to be installed will not consume more than 15 1-4 pounds of steam per I. H. P. per hour, so that the boilers must be able to evaporate $1,800 \times 15\ 1\text{-}4 = 27,400$ pounds of water per hour. With the boilers kept clean, as they should be, it is safe to assume that each pound of coal burned on the grates will evaporate 9 pounds of water, therefore there must be sufficient grate area to burn $27,400 \div 9 = 3,044$ pounds of coal per hour. With a smokestack of not unusual proportions, 16 pounds of coal can be burned per hour per square foot of grate, so the grate area necessary is $3,044 \div 16 = 190$ square feet.

This grate surface can be provided in a number of ways: first, in one large double-end, eight-furnace boiler; second, two large single-end, four-furnace boilers; third, three moderate-size single-end, three-furnace boilers; or, fourth, in four single-end, two-furnace boilers. It would not be wise to depend solely on one very large boiler for steaming, so, aside from the advantages of dividing the boiler power into two or more units, the space occupied will have to be considered, as that has much to do with the arrangement and capacity of bunkers.

In the first, second, or the fourth combinations, where there are eight furnaces in all, each furnace would be given a grate area of 23.75 square feet; the grates would be 6 1-2 feet long, so the furnace flue should be 3.65 feet internal diameter, and a corrugated furnace of 44 inches least internal diameter would be used. In the three-furnace boilers each of the nine grates must have an area of 21.1 square feet; with 6 1-2-foot grates each boiler would require three

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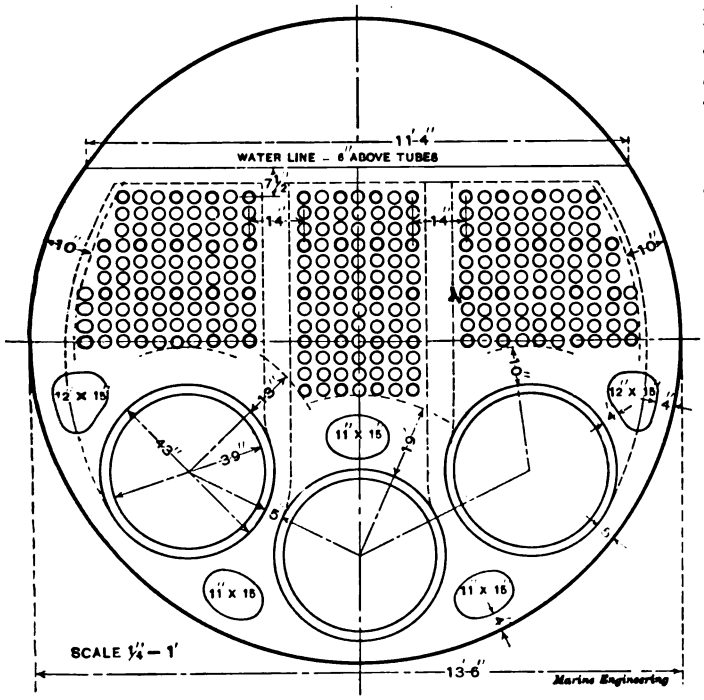
corrugated furnace flues of 39 inches least internal diameter.

Experience or observation should tell the designer that a shell about 16 1-2 feet in diameter is necessary to accommodate four 44-inch furnaces, so it is assumed for the present purpose that the double-end and large single-end boilers would be 16 1-2 feet diameter. In the same way it is known that the three- and two-furnace boilers would be about 13 1-2 feet and 11 1-2 feet in diameter, respectively. The lengths of the boilers would be about 20 feet for the double-end and 11 1-2 feet for the single-end. Making allowance for fire rooms, the double-end boiler placed fore and aft would occupy at least 38 feet of the length of the vessel, so it will be considered that with any arrangement that length is given up to boiler and bunker space.



PRINCIPAL DIMENSIONS OF A SCOTCH BOILER.

Suppose the general dimensions of the steamer are. length 290 feet, beam 46 feet, depth 21 feet, then the plan of the space allotted to boilers and bunkers can be drawn to scale as a rectangle 46 feet by 38 feet. An average height of at least 15 1-2 feet could be obtained for the bunkers. Trying the different boiler arrangements in the rough scale drawing, it is found that with the double-end boiler two side bunkers with a total capacity of about 350 tons could be arranged; with the two large single-end boilers, two side bunkers and one athwartship bunker with a total capacity of about 340 tons; with the three single-end boilers, two side bunkers and two bunkers forward of the fire room, connected by a small athwartship bunker, with a total capacity of about 320 tons; and the four boilers permit an arrangement of two side bunkers connected by a small athwartship bunker, with a total capacity of about 300 tons.

The large double-end boiler would give somewhat less weight than any of the other arrangements, and two boilers would give a slight advantage in that respect over either the three- or four-boiler arrangements. Considerations of space occupied fore and aft recommend the use of the two large boilers, but smaller boiler units seem to be desirable. The use of three boilers gives good bunker space, and boilers of moderate size built of plates of moderate thickness. With four boilers, the subdivision of boiler power is carried still further and the plate thickness further reduced. They would prove very satisfactory in operation, but from considerations of weight, cost, convenience in operation, etc., it is decided best to use the three boilers of moderate size.

It now remains to distribute the proper amount of heating surface, which includes the effective surfaces of the furnaces, combustion chambers, and tubes. A proper volume of steam room and area of water surface must be assigned, and it must be seen that there is a sufficient volume of furnace and combustion chamber above grates to insure proper combustion. The area of water surface is usually measured at a height six inches above the highest tubes, so when that has been determined, the height to which the tubes can be carried is also determined. Two square feet of water surface per square foot of grate area is a fair allowance, which gives to each of these boilers an area of water surface of 126 square feet when the water is 6 inches above highest tubes.

It is now necessary to make a scale drawing of the boiler in cross-section showing the arrangement of furnaces and tubes. It is known that the boiler should be about 13 feet 6 inches in diameter and about 11 feet 6 inches long, so for a first trial these dimensions will be used to see if they are suitable to permit of a proper arrangement of furnaces and tubes with sufficient steam room, room for cleaning, etc. It is assumed that the above are inside dimensions. The area of water surface, 126 square feet, divided by the length of boiler, 11.5 feet, gives 11 feet, which to represent the water level should be drawn as a horizontal chord to the circle in the figure, whose diameter is 13 feet 6 inches, and another horizontal line 6 inches below it will represent the height to which the tubes can come. Three-inch tubes will here be used, as they are generally considered good size; 2 3-4-inch tubes are also largely used. The furnaces should be separated from each other and from the shell by about 5 inches.

The greatest external diameter of the furnaces will be 43 inches, so the circles representing them are drawn that diameter. The tubes should be spaced horizontally, so that they are separated by about one-half their diameter, vertically. An inch space is sufficient with 3-inch tubes, which will make the spacing of the tubes 4 1-2 inches between centers horizontally and 4 inches vertically. Sufficient space, about 10 inches, must be left between the tubes and the shell and between the nests of tubes to enable an ordinary man to work down to the furnaces and remove any deposits. Each furnace has its separate combustion chamber. Accessibility for cleaning will not only make it possible to maintain the efficiency of the boiler, but to prolong its life. The water side of the furnaces, particularly, should be easy of access for cleaning and inspection. Giving the above matters due consideration,

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the arrangement in the drawing is the result, which shows that a shell 13 feet 6 inches in diameter is just about right.

Allowing 2 feet 6 inches for depth of combustion chambers and about 7 inches for the water space between combustion chambers and back head, the length of tubes, if the boiler is to be 11 feet 6 inches inside heads, will be 8 feet 4 inches inside tube sheets; the length of the furnaces will be the same. The heavy circles among the tubes indicate stay tubes, which would have a thickness of about 1-4 inch. From these data and the drawing the results given below were obtained for one boiler:

Steam pressure	160 lbs.
Diameter of shell	13 ft. 6 in.
Length of shell, inside heads	11 ft. 6 in.
Number of furnaces	3
Inside diameter, least	39 in.
Grates, length	6 ft. 6 in.
Grate area	63.6 sq. ft.
Diameter of tubes, outside	3 in.
Number of tubes, total	275
Number of stay tubes	58
Length of tubes, inside tube sheets	8 ft. 4 in.
Heating surface, tubes	1,800 sq. ft.
Heating surfaces, furnaces	134 sq. ft.
Heating surface, combustion chambers	204 sq. ft.
Total heating surface	2,138 sq. ft.
Cross area of tubes for draft	11.15 sq. ft.
Area of water surface 6 inches above top, tubes	130.3 sq. ft.
Steam room	279 cu. ft.
Volume of furnaces and combustion chambers above grates	273 cu. ft.

Ratios:

Tube H. S. ÷ G. S	28.66
Furnace H. S. ÷ G. S	2.13
Combustion chamber H. S. ÷ G. S	3.25
Total H. S. ÷ G. S	34.04
Tube H. S. ÷ total H. S	.842
Furnace H. S. ÷ total H. S	.063
Combustion chamber H. S. ÷ total H. S	.095
Cross area tubes for draft ÷ G. S	.177
Water surface ÷ G. S	2.07
Steam room ÷ G. S	4.44
Volume of furnace and combustion chambers ÷ G. S	4.35

In marine boilers the ratio of total heating surface to grate surface varies from 25 to 40, with 30 a very common ratio; but where the rate of combustion is above the ordinary, it is best, for the sake of fuel economy, to exceed 30, the ratio obtained with the length assigned to the boiler under consideration being about right for the rate of combustion to be maintained.

All the principal dimensions, ratios, etc., for the boiler have now been determined, and the next step is to calculate the riveted joints and the staying of the flat surfaces, a subject which will be treated later.

(To be continued.)

MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK.

The forty-eighth annual meeting of the American Society of Mechanical Engineers takes place in New York December 1 to 4. Owing to the increased attendance at these meetings it has been decided to hold some of the sessions in larger halls. On Tuesday and Friday the professional sessions will be held at the society's headquarters, 12 West Thirty-first street; on Wednesday, in the hall of the Mendelssohn Union; and on Thursday at the Stevens Institute of Technology, Hoboken. The annual address of the president, Mr. James M. Dodge, will be delivered on Tuesday evening, and the subject is "The Money Value of Technical Training." On succeeding days the papers taken up are to be as follows:

"The Pitot Tube," by W. B. Gregory.

"Method of Determining Rates and Prices for Electric Power," by F. B. Perry.

"Three- and Four-Wire Multiple Voltage Systems," by Louis A. Gillet.

"Test of a Compound Engine Using Superheated Steam," by D. S. Jacobus.

"The Pressure Temperature Curve of Sulphurous Anhydride (SO_2)," by E. F. Miller.

"Construction and Efficiency of a Fleming Four-Valve Engine," by Benj. T. Allen.

"Compact Gas Engine; Beam Type," by C. H. Morgan.

"Standard Unit of Refrigeration," by J. C. Bertsch.

"Series Distilling Apparatus of High Efficiency," by W. F. M. Goss.

"Air Motors and Air Hammers, Apparatus and Methods for Testing," by Max H. Wickhorst.

"Valve Motion of Duplex Air Compressor," by S. H. Bunnell.

The social feature of the session will be a reception and *conversazione* at Sherry's on Thursday evening, and on Wednesday afternoon parties are to be arranged for visiting the power stations in New York city. Thursday afternoon will be spent in viewing the laboratory, shops, and drawing rooms of Stevens Institute, and on Friday afternoon the De Laval Steam Turbine Company will form an excursion to visit its works at Trenton, N.J.

Oil-Burning Steamers on the Pacific Coast.—Permits have been granted by the United States Inspector of Steam Boilers at San Francisco to use oil on 123 vessels with a total registered tonnage of 100,437 tons. These vessels are of all classes and sizes from harbor boats to large ocean steamers.

Supervising Inspector-General's Annual Report.—Mr. George Uhler, supervising inspector-general, has submitted his annual report of the Steamboat Inspection Service. No mention is made of the proposed changes of the law and the revision of the rules and regulations as to the result of the special session of the Board of Supervising Inspectors at Washington in June last. These recommendations have been submitted to the Secretary of Commerce and Labor. A decreasing number of violations of the law are reported, owing to the department imposing the fines for such violation. The total number of accidents of all kinds, mostly resulting in loss of life, during the fiscal year, was only forty-nine, of which four were caused by boiler explosions.

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Revival of Our Shipping.

In commenting upon the article and letters which appeared in the November number of MARINE ENGINEERING concerning the shipping question, Professor Trowbridge, of Columbia University, has written to the New York *Sun* on some of the conditions which tend to make the cost of building and operating American ships higher than those of other nationalities. Means of remedying these two conditions he gives in part as follows:

"One advantage that could be given to ships built in this country would be to put an export duty on coal and have this duty apply to all coal supplied to any foreign-built ship, and not to coal supplied to American-built ships registered here. This would be a source of revenue to the government and not an expense, as a subsidy would be. Such a duty would not be unjust, as it would merely be a case of charging the foreigner a certain amount more than our own people were charged for some of the mineral produced here. This duty would be especially beneficial to the large, swift steamer which uses such great quantities of coal, but not at the expense of the freight ship, as the latter would have an equivalent advantage over any foreign-built vessel of its own class.

"The price of an American-built ship is from 25 to 75 per cent. higher than for a similar ship built in Great Britain, depending largely on the type of vessel. Why this is so is usually explained by the greater cost of labor here than abroad. There is good reason to doubt, however, that the blame should be placed on the cost of labor. Certain it is that American labor is well paid, but it is not better paid in shipbuilding than in the two industries that employ exactly the same kind of labor, namely, bridge building and locomotive building.

"In any large shipyard the organization is naturally separated into two divisions of hull department and engine department. The work of the hull department is exactly parallel to that of a bridge-building concern, and the work of the engine department to that of a locomotive works. Of course, there are peculiarities in hull work not involved in bridge building, such as bending the frames and the great amount of warped surface on a ship, but on the whole the two are practically parallel. Likewise, there are differences in the engines and auxiliaries used on a ship from those on a locomotive, but in the main features of manufacture they are parallel.

"It has been shown that American bridge builders and American locomotive manufacturers can undersell English and European manufacturers of the same goods. Such being the case, what is the reason the American shipbuilder, who uses the same kind of materials and employs the same kind of labor, cannot undersell his foreign competitor?

"There is a simple, definite answer to the question, and it is that the American shipyard is not operated as economically as either the bridge or locomotive shop, because it is not as well organized and conducted. The principal reason for this is not the lack of brains or effort on the part of the men at the head of the shipyards, but because the effort exerted has been to cheapen the product rather than to lessen the cost of producing it. In almost any of our American shipyards the expense of the office and drafting rooms could be easily reduced to one-half what it is at present. If the shops and yard were looked after more carefully, and a proper system of piecework introduced, it is safe to say that almost as large a reduction could be made in the expense of these departments. It is because of their efficient organization that the large British shipyards are able to do work so cheaply, and not altogether because of the low wages they pay.

"Let Congress give the American-built ship enough advantages to compensate for the higher cost of operating American ships, due to our shipping laws, and the merchant marine of the United States will take care of itself."

The above letter called forth a reply from Mr. Alexander R. Smith, superintendent of the Maritime Association of the port of New York, and, while heartily agreeing with Professor Trowbridge that the American ship must be protected in some measure by legislation, he points out that it is impossible to build ships and their engines along similar lines as used for locomotive and bridge building. He states in part as follows:

"The building of locomotives and bridges in the United States is a great, permanent industry. With our 200,000 miles of railroads—nearly equal, I believe, to that of all the rest of the world—the demand for locomotives and bridges is enormous. Moreover, they are standardized to a degree quite impossible in the construction of hulls and marine engines. The wonderful efficiency of our locomotive and bridge builders is due to the perfection of their system of construction, the regularity and stability of orders, and upon an enormous scale; a condition that does not in any degree approximate in the building of hulls and marine engines, where the demand is infrequent, spasmodic, fitful, and intermittent. The ship and engine building establishments must be ready to take contracts at all times, thus entailing fixed charges that bear very heavily upon the small product that is turned out, and which accounts for the comparative high prices of our ships and engines. In bridge and locomotive building these fixed charges are distributed over a product so large as to make the cost extremely low.

"Let the demand for American-built ships once be created and steadily maintained, as it so long has been for locomotives and bridges, and I am able to assure you that the cheapness and effectiveness of American-built ships will compare quite favorably with that of those built abroad, as the cheapness and effectiveness of American locomotives and bridges compare with those of foreign construction.

"How to create the demand for American-built ships is the all-absorbing problem—that is the kernel of the nut that has got to be cracked. Whether it will be by subsidies, or bounties, or by differential tonnage and tariff dues, or by export duties or bounties, I am unable to say; but of this there is no doubt: the American people will never be satisfied until the problem is solved, and the friends of American shipping welcome the discussion of the subject by all who, like Prof. Trowbridge, declare themselves in favor of American-built ships. The more the subject is discussed, in the spirit of inquiry and patriotic interest displayed by Prof. Trowbridge, without prejudice against, but rather in favor of, American-built vessels, the nearer we approach a discovery of a method at once practicable and effective."

Positions Vacant.—The United States Civil Service Commission announces that examinations will be held on December 15 and 16 at large cities throughout the United States for the following two positions: First, assistant steam engineer, at a salary of $720, in the War Department; second, position of local and assistant inspector of boilers at Portland, Me., at a salary of $1,800 per annum. All persons desiring to compete should at once apply to the U. S. Civil Service Commission, Washington, D. C., for proper application forms.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

IT is seldom, indeed, that these columns are devoted to politics, and yet, as the events which have taken place in our state and national affairs in the last few weeks portend to bear most beneficial results to our present demoralized and more or less inactive shipbuilding industry, we present them to our readers. Citizens throughout the country are evidently becoming better posted concerning the condition of our merchant marine. Through the efforts of the New York Board of Trade and Transportation, the Home Market Club, of Boston, and others, the facts of the present condition of American shipping have been forcefully brought before our citizens. The general discussion of the question has taken place in the daily press throughout the country, and editorials are to be found in practically every inland paper dealing with the question at large or with the benefits that a special section of the country would derive if our commerce were more generally carried in American ships. The results of this campaign of education carried on through the above-mentioned agencies are shown in no uncertain way.

The election in Ohio of a Republican legislature by an overwhelming and unprecedented majority means more than a victory for that party in the state election. Every voter knew perfectly well that if a Republican legislature were elected it would return Senator Hanna to the United States Senate. It was Senator Hanna who made such a strong fight for subsidy in Congress. His record on this issue was most bitterly attacked by his opponents in this campaign, but he reiterated his belief in the necessity and principle of protecting American ships, and stated in every public address that if he were reelected he would again take up this issue and not be content until he had succeeded in obtaining from Congress necessary legislation. The overwhelming verdict in favor of this principle, coming as it does from the inland state of Ohio, may readily be looked upon as a sign of the times.

In New York State, by a majority of about two hundred thousand votes, the citizens decided in favor of building a one-thousand-ton-barge canal from Buffalo to the Hudson, although they thereby entailed upon themselves a prospective outlay of over one hundred million dollars. They considered this a small amount in view of the increased commerce which will be brought into the state by the new canal. This will require a new type of canal boat and should bring much work to the yards of Lake Erie and New York harbor.

The establishment, and recognition by this country, of the new-born Republic of Panama has settled for all time the question of a transisthmian waterway and the part in which this country is to take in it. Our government will now construct the Panama canal, and that right speedily, so that within a few years we may expect to see this great waterway open for commerce. It is reasonably anticipated that this will be immediately followed by an immense expansion of trade between our Pacific and Atlantic states, and a new field of commerce will be opened for merchants on the western coast of South America.

Although the present conditions in shipbuilding are most deplorable, yet the indications as we look ahead into the near future are, in our opinion, more auspicious for increased and continuous work than in the past many years. The failure of the Shipbuilding Trust should be looked upon with satisfaction now that it is past, rather than with regret. The organization, as has been most clearly brought to light through recent investigations, had neither excuse nor possibility to

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live, overcapitalized as it was and organized with a most barefaced purpose to defraud the public. Its collapse has clarified the atmosphere of suspicion and uncertainty, and the industry may now develop along natural lines with the assurance that never again, at least not until the memories and history of this monumental scandal have been forgotten, will it be subjected to the stock manipulators' designs. The public have seen and felt the over-capitalizing folly and learned the lesson. The conditions of trade throughout the country seem to be improving; the crops—the real wealth of our nation—are enormous, and railroads are reporting increasing earnings. So it is that we may look forward with a degree of certainty to the healthy growth of our shipbuilding to meet the increasing demands of foreign trade under the protection of wise legislation.

THE annual meeting of the Society of Naval Architects and Marine Engineers may be looked back upon by the attending members as full of interest, for considered as a whole the papers read were good and elicited some interesting and valuable discussion. Upon the preceding pages of this issue we give abstracts of the papers, and the resulting discussion but slightly abbreviated, and recommend its careful perusal to our readers. The first paper on the trial of a ferryboat is not only of general interest as dealing with a comparatively new class of boat, but also of most timely interest in view of the prospective contract by the City of New York for five high speed ferryboats for the Staten Island service. There is but scant similarity between the new ferryboat in point of design, construction, arrangement and powering and her side wheel predecessor. These boats hold a most important part in our transportation systems, especially in and about the harbor of New York. Most of the railroads which operate ferry services are replacing the side wheeler with steel boats equipped with screws. Colonel Stevens was the first to apply this system of propulsion to the ferryboat, and its success is shown by the fact that all the new boats are built on this line. As the boats have screws at either end, the bow screw has introduced a new and undetermined factor in this already complex problem of screw propulsion. Shipbuilders have really done little to ascertain the best form of hull and propeller for this class of work, and the investigations of the author of this paper, taken with those already published by him on this subject, prove valuable additions.

The paper on steam piping and especially the resulting discussion contain some good points on a subject which to the present has been given but scant care. A leaky joint, a split coupling or fitting, a burst steam pipe are some of the frequent incidents that the marine engineer has to contend with because of the faulty design either in the fitting itself or in the lay-out of the piping which does not allow for expansion. Thus repair work done at sea has to be done under the most trying conditions. The substitution of steel for copper in high steam pressures is shown to be a step in the right direction. A third paper, illustrating the advance made in materials entering into the construction of boilers, is given under the heading of non-corrosive nickel steel boiler tubes. The life of this tube is stated to be two and one-third times that of the usual low carbon steel tube. At the same time the reduction in weight is considerable, amounting to many tons in a high powered ship, more than offsetting the increased first cost and decreased cost of maintenance.

Much of the second day's session was devoted to the subject of launching both large and small ships, and the members did not hesitate to give out the data of these calculations as well as in some cases that of the ships themselves. In some of the papers and discussions there was more or less of a personal element entering in, but fortunately the bulk of the matter is as it should be, strictly professional. The theoretical side of naval architecture was duly represented in several papers presented, three of which were in the line of shortening the work of calculations of a ship's form. The one by Mr. Taylor should be looked upon as a long step in advance in deducing formula for laying down the lines of ships. This work, the result of an extended series of investigations at the experimental tank in Washington, contains most valuable data for the naval architect. Other good papers were presented, but limited space does not permit mentioning here, and of the poor ones which were unfortunately included, we pass without comment.

Taken as a whole, we may look upon the meeting as another step in the advancement of the art of shipbuilding with an increased disposition on the part of the members to give out their personal data which they have been accumulating, for the good of the Society.

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An Oiler's First Experience, or the Practical Side of Marine Engineering.

BY ALBERT R. EMMONS.

Having worked in the engineering department of a number of ocean steamers and also served as stationary engineer on shore, I know by comparison how hard and really full of danger the marine engineer's life is. I well recollect my first oiling experience at sea. I had been working at stationary engineering for a number of years, yet always had a taste for the water, having traveled at sea considerably as a passenger and not being affected by seasickness; so, when the opportunity came, I shipped as oiler on a mail-fruit steamship running between Boston and Jamaica. She was 2,104 tons gross, with an average speed of about 14 knots. There were two single-ended Scotch boilers, fitted with Howden draft and having a total of eight fires. The engines were triple-expansion, twin-screw, three-cylinder, three-crank, vertical-inverted, direct-connected, fore-and-aft, double-bar Stephenson-link motion of 3,000 aggregate horse power, turning up 125 revolutions. There were also two blower engines, two air pumps of the twin-cylinder beam type, two circulators, two dynamo engines, steam steering gear, and about a dozen duplex pumps of all sizes, for bilge, sanitary, feed, ballast, fresh water, etc. All this machinery was crammed into a small engine room, where every square foot of room was utilized. We carried four engineers, six oilers, nine firemen, three coal passers, and a cadet engineer. They represented about a dozen different nationalities.

We left Boston about 7 P.M. September 13. I was in the 8-to-12 watch, and came down into the engine room ahead of time to get initiated. We had just backed out of the dock amidst a din of whistles, clanging of telegraphs, and multiplicity of orders. Most of the engineers and oilers were on duty and there was lots going on. Engines were worked ahead and astern, steam was escaping, auxiliary machinery pounding, and water flying. Soon the port air pump stopped; while, at the same time, a link end got warm on the port engine, which was immediately followed by a message down the speaking tube that the steering gear would not work. Here was trouble right off. The chief was yelling and bawling out orders from the top platform, the first assistant was trying to start the port air pump, and the second was doctoring that link end. To add to this, the dynamo began to race and the bilge pump would not suck water. Strange to say, in a few minutes everything was straightened out, but in such a cool, dare-devil fashion that I was hugely surprised. They have such quick ways of doing things in a marine engine room!

Soon after this we were outside Boston Light, going ahead with everything wide open. How is it possible to describe the confused mass of flying rods, accompanied by the most infernal racket? The air seemed to be full of cranks, crank pins, connecting rods, piston rods, shafts, thrust bearings, links, valve stems, eccentrics, eccentric rods, cylinders, blowers, circulators, dynamos, pumps, steam, hot water, cold water, oil, grease, copper pipes, fearful profanity, and the most infernal, terrible, whackety-bang thunder, that I believe it would scare the devil himself. It seemed as if forty boiler shops were all condensed together.

Everybody had knocked off except the regular watch. The third assistant was in charge, with myself and another oiler; I looked after the port engine and all the auxiliaries on that side. It was necessary to put one's hands into all sorts of dangerous places to feel the different bearings. This is dangerous work; but one gets used to anything in this life.

Pretty quick the feed-water heater up overhead overflowed, and down upon us fell an awful shower of terribly hot water. The other oiler rushed under and speeded up the feed pump, accompanied by the most horrible execrations from the engineer of the watch. Next the bilge strainers got choked, and, the first thing we knew, all six cranks picked up the water and shot it all over the place. This called forth hair-raising adjectives and nouns from the third assistant (whom we will call "Nidgren"). In a voice which sounded like a circular saw when it first bites into a big log, he ordered me to clear out the starboard bilge strainer. I had to reach halfway down into a hole 20 inches square, out of which a lot of pipes emerged (some of them pretty hot), to get at the strainer. Within a foot of my head the flywheel of a blower was revolving at 800 revolutions per minute. It was very fatiguing, holding on with one hand and taking out ashes with the other. At one time the water was so high that I had to put my head under.

The voltage on the dynamo next began to work up and down between 80 and 140 volts. This was adjusted by using the throttle. The governor evidently did not work as it should. Then the port air pump got stuck again, dropping the vacuum down to 5 inches before any one noticed it. Nidgren could not start it at first, so he opened a valve, which allowed the other pump to work on both condensers together. After numerous pryings with a pinch bar, screwing of nuts, and applications of cylinder oil, it was finally started again.

The main slides had to be dosed with extra oil every half hour. To get at the intermediate I had to go up to the first grating, crawl through and around a lot of pipes and pumps, finally to shove my hand through an opening and squirt the oil. While doing this about two quarts of hot water dropped on my bare neck, causing me to jump so that I nearly fell into the engine.

During one of my attempts to swab the main rods, the brush got mixed up with the crosshead in some unaccountable manner, and away it went clear across the engine room. This called forth another shower of fearful expletives from the third assistant. Next a crosshead key fell out of the feed pump, which consequently stopped, and the natural conclusion was another shower of screaming hot water. I was told to crawl into the bilges and hunt for it. A floor plate was taken up and I squeezed into a heterogeneous collection of crooked copper pipes down underneath the feed pump, where there was plenty of grease and dirty water. The key was finally recovered. In trying to get out, my head came into violent contact with the sharp edge of something, nearly knocking the senses out of me.

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About this time the port circulator began to heat at the crank pin. Salt water had to be squirted at it from one of the service pipes on the main engine, immediately followed by a good dose of oil. Pretty quick a piece of packing blew out of a joint on the starboard engine, the steam flying out with a blood-curdling screech. The engineer next sent me out into the fire room for some tool or other.

Arriving there, a new scene was encountered. The air seemed to be full of red-hot slice bars, rakes, hoes, shovels, coal and fine coal dust, ashes, bull niggers, Poles, Spaniards, steam, and water. Doors were yanked open and slammed to; hot fire was falling on to the floor in all directions; and, taken altogether, it reminded me strongly of what the infernal regions are supposed to be like. It so happened that, right at this juncture, a gauge glass suddenly flew into a million pieces with a report like a small cannon, filling the air with hot water, steam, and broken glass. Nidgren, the engineer, came onto the scene just then and let out another long string of unhallowed expressions. The valves were shut in some way or other, a new glass procured and put in.

After being at sea a couple of days, a gale of wind was encountered which blew dead ahead, which made still more excitement down below. A man stood at each throttle to control the runaway engines. As the ship would pitch down and up out of water, both propellers would come, necessitating the quick shutting off of steam, so that the speed would not be so great as to snap the blades off the wheels when they struck the water again. When they raced, I should judge that the engines made about ten million turns a minute. This is very hard on the shafts and is the principal cause of their breakage.

The bilges gave lots of trouble during this rough weather; keeping them clear was nasty work. It was also very hazardous crawling around among the engines, holding on with one hand, feeling and oiling with the other. Taken altogether, there was bedlam let loose—the greatest hullabaloo imaginable.

Out in the fire room things were even worse. Very thick fires were carried, it being necessary often to get on top of the slice bars to crack the raging mass of hot coal. The ship would give a tremendous roll, knocking the poor devils flying against a sharp angle iron or ugly projection. Then another would endeavor to coal up, but most of the fuel went all over the boiler front. The water was pitching up and down—away above the top of the glass, then with a rush away below the bottom: pretty hard to tell just where it was.

When about half way, or a little further, on the passage, we had the misfortune to blow a fusible plug. This happened at 1 o'clock in the morning. The engineer in charge had just left the fire room when one of the firemen screwed the forward check down solid and forgot all about it. In about twenty minutes the plug melted out with a frightful scream. This scared everybody, so that all made a rush for the deck, and not one of them came back until driven down later on. The first assistant somehow was notified and bolted out into the fire hold. It was a pretty mess—a big boiler with four heavy fires, forced draft, low water, and no one in sight! The second assistant shut down the fans, while the first and one oiler started to haul the forward fires. This was an awful job; as fast as they got out some fire, the hose played on it until the air was chock-full of smoke, steam, coal, and ashes. It was finally done, however; next the forward stop valve was shut, and then the blow-off opened, emptying the boiler in a few minutes. Some planks were placed on the grates, and the chief crawled into the back connections to examine the top of the combustion chamber. This was found not injured; but the hole in the fusible plug had to be filled, and there was no spare plug aboard. A thread was tapped into it and a piece of a bolt screwed in. They hauled out the chief more dead than alive, pumped the boiler up with hot water, and shoveled in the fires again, together with a lot of hot coke from the after boiler. In less than four hours after the plug went, that boiler was working at its full capacity. This is the way they do things at sea.

When the ship arrived at Jamaica we began to be troubled with the most fearful heat. Oh, how unbearable it was down in that seething hot caldron of iron and steel! I had to help pack the main rods, during which operation I expected to faint with the intense strain. I put a bunch of wet waste in my cap to keep my head cool. No ordinary thermometer would register enough to indicate the temperature.

There were also other diabolical jobs to be done; for instance, to pack a pump while lying on your stomach among a lot of dreadfully hot pipes, reaching around in vain attempts to get at it, and hot drops of water hitting you; but it had to be done.

I was glad to get started North again, so as to get out of this paralyzing heat. But there is an end to everything, if you wait long enough, and the time finally came that we arrived home again.

All the foregoing is what one may expect who wants to go to sea in the engine room of an ocean steamer. I have not exaggerated things in the least; in fact, they are not painted black enough. If the men or boys who design the machinery also had to do the work, it would be considerably easier. For instance, have the bilge strainers more easy of access; run the piping a little different, so as to get at auxiliary engines better; arrange a good many of the valves so that it is easier to get at them. Many other little details, if slightly modified, would lighten the labor very much and at the same time be just as cheap.

I have very seldom seen any one employed on a steamship who was glad he was there; he always wished he had a job ashore. It is nothing but hardship, poor food, insufficient sleep, all kinds of vermin, to make life miserable. But there is a most wonderful chance to learn how to run engines and boilers in a practical manner.

Wireless Telegraphy.—The latest reported application of wireless telegraphy for marine protection is that of equipping the seagoing tug *Savage* with DeForest wireless system, by which it is possible for the tug to be in communication with the shore throughout her voyage between Boston and the Chesapeake capes. In case of barges breaking away in a heavy gale, the tug will be able to send a message ashore for assistance.

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Experiments on Screw Resistances.

Editor MARINE ENGINEERING:

Allow me, please, a few remarks regarding the interesting experiments with the steamship *Vlaandringen*, described in your magazine by H. Emes Van Gelder.

To get the real thrust delivered on the thrust block a dynamometer was employed, and this showed that owing to the influence of the propeller, the resistance was considerably in excess of the resistance calculated from the tank trials—a result which might be anticipated from the full aft body and the proximity of the screw.

In order to get the part of the I. H. P. absorbed by the ship for propulsion, Mr. Van Gelder multiplies the measured thrust (augmented resistance) in the speed of the ship. This would have been correct if the propeller would have been working in water at rest, but the fact that the screw worked in the wake alters matters considerably; and while the resistance is increased by the disturbance in the wake, on the other hand a saving in power is obtained by reducing the revolutions required for a given speed.

According to Mr. Froude's experiments, the loss due to the resistance augmentation, and the gain by the working of the screw in the wake of the vessel, equal each other, so that thrust H. P. practically equals I. H. P. If the H. P. absorbed by the propulsion of the ship had to be ascertained, the measured thrust (augmented resistance) ought to be multiplied by the speed of ship minus speed of wake, and by so doing we certainly would not get the impossible efficiency of 0.7 for propeller and engines together.

It is interesting to notice that in all experiments carried out with dynamometers, in which the thrust measured was multiplied by the speed of the vessel in order to obtain the work delivered by the screw, excessive high efficiencies were calculated, for the above-mentioned reasons.

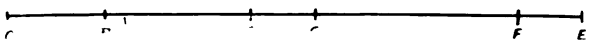
A clear example are the French experiments with the *Elorn*, giving 85 per cent., and Isherwood's, with over 80 per cent. If the resistance augmentation of the model of the *Vlaandringen* would have been ascertained by trying it with the screws working behind it, a very interesting comparison could have been made between augmented resistance of model and the augmented resistance of the real ship measured on the thrust block.

Nowadays models in the tanks are tried with the propellers working behind them, and the position of the screws is fixed up so as to compensate as much as practicable the augmentation in resistance by the gain due to the working in the wake; but it remains still an open question if the position of screw giving the best results for the model is also the best for the ship. This question can only be answered by measuring the augmented resistance with dynamometers on ships and comparing the results with tank trials with and without screws.

A. MELENCOVICH.

The significance of the phrase, "power absorbed by the ship for propulsion," depends somewhat upon the manner in which it is used, and different writers may fairly use the term with different meanings. The simple fact is that there are all sorts of quantities related to the power problem: indicated horse power, power delivered to propeller, thrust power, net propeller power, and effective horse power. These various quantities admit of comparison, and all sorts of relations may be developed between them.

These relations may be well illustrated by a diagram as follows:



Let the total I. H. P. be denoted by the length AE. Then the various ways in which the power may be subdivided are represented as follows:

AE = I. H. P. = total power.

AB = power absorbed by friction of engine and attached pumps.

BE = power delivered to propeller.

BC = power absorbed in eddies, rotation, and sternward acceleration communicated to the water acted on, assuming the existence of a wake.

BC_1 = power absorbed under the preceding head, assuming that there is no wake and that the propeller works in undisturbed water.

CE = thrust horse power = product of actual thrust by the speed of the ship relative to the outlying still water.

C_1E = reduced thrust horse power = actual thrust multiplied by the reduced speed of the ship relative to the wake = net propeller power.

FE = power absorbed by the augmentation of resistance.

CF = power absorbed by the true or towed resistance in the case with wake = effective horse power.

The various ratios are also illustrated as follows:

$\frac{CF}{AE}$ = propulsive coefficient.

$\frac{CE}{BE}$ = apparent propeller efficiency.

$\frac{C_1E}{BE}$ = true propeller efficiency.

$\frac{CE}{CF}$ = coefficient of augmentation.

$\frac{CE}{C_1E}$ = wake-return factor.

$\frac{CF}{C_1E}$ = hull efficiency.

Now, the quantities represented in column 12 of table 1 in the article referred to are values of the thrust power, represented by CE in the diagram, and the author seemingly chooses to term this the power utilized as the work of propulsion, and the quotient of this divided by the I. H. P. as the fraction of the total developed power utilized as the work of propulsion. So long as it is perfectly clear what has been done, there need be no confusion; and if the terms employed are not in accord with those which might be preferred, the facts themselves are in nowise affected.

Our correspondent has, presumably by oversight, not expressed his real meaning in stating that, due to the balance of augmentation loss and wake gain, the thrust H. P. practically equals the I. H. P. In the

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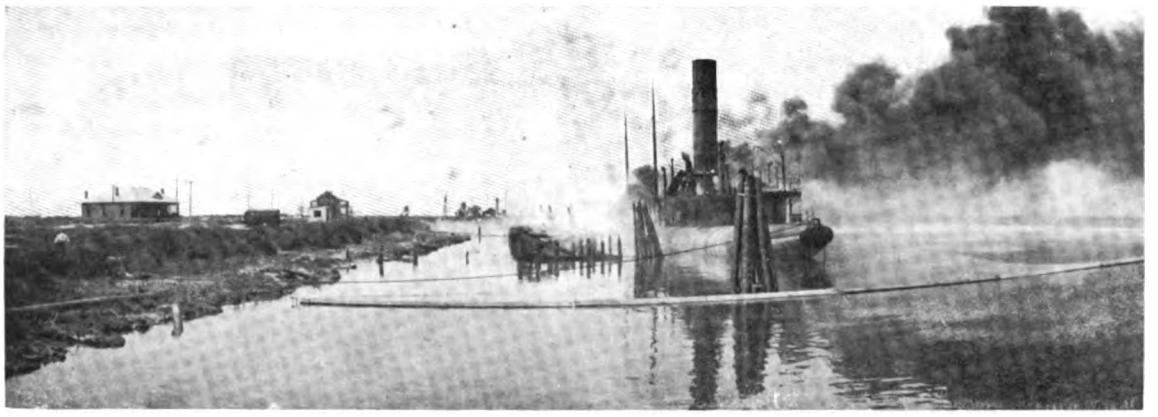

THE OIL CARRIER CITY OF EVERETT BURNING AT PORT ARTHUR, TEX.

diagram this would call for substantial equality between *CE* and *AE*. As will be seen from the analysis above, the hull efficiency is the ratio of *CF* to C_1E, the effective horse power to the net propeller power, and it is this ratio which the experiments of Mr. Froude showed to be nearly unity. In other words, in so far as wake gain and augmentation tend to balance, so will *CF* and C_1E tend toward equality. It is, therefore, these two quantities to which our correspondent presumably refers in calling attention to their equality under a balance of wake and augmentation effects.

The value of .70 for *CE* divided by *AE* is by no means unusual or extreme. It should not be confused with any of the other ratios mentioned above. These could only be known by a detailed analysis which would give for the ship both the augmentation and wake effects. These were not in hand, and the author therefore gives simply the discussion of such results as came directly from the observations made.

We are quite in accord with our correspondent in urging further measures of actual resistance on full-sized ships for comparison with tank trials, with and without screws, in order to throw further light on this important question.

Lloyd's Register Shipbuilding Returns.—From the returns compiled by Lloyd's Register of Shipping for the quarter ended September 30, 1903, it appears that, excluding warships, there were 393 vessels, of 906,608 gross tons, under construction in the United Kingdom. This shows a decrease in the tonnage under construction of about 122,000 tons as compared with the figures for last quarter, and a decrease of about 507,000 tons as compared with the total reached in September, 1901, which is the highest on record. The tonnage for the quarter ended September 30, 1903, is divided as follows: 353 steel steam vessels, of 889,035 gross tons; one steam composite vessel of 220 gross tons. The sailing tonnage consisted of 39 vessels, of 17,353 gross tons, 12 per cent. of the tonnage being of steel. Of the total tonnage for this quarter, 310 vessels, of 743,650 gross tons, were built for parties in the United Kingdom. The battleship construction for this period at private and government yards was 64 vessels, of 327,570 tons displacement.

Tank Ship Burns.

On the night of September 7 the oil-tank steamer *City of Everett*, of the Standard Oil Company, took fire while receiving a cargo of oil at Port Arthur, Tex. The vessel was lying at the Texas company's oil wharf No. 3, and had just about received her full load of 1,200,000 gallons. It is asserted that fire was caused by an explosion of gas in one of the holds, the gas being ignited by a spark caused by defective insulation of a portable electric light. The second officer of the ship was holding the light in a hatch to note the progress of loading. When the explosion took place the ship was at once enveloped in smoke and flames, and the crew had to take to the water. There were no facilities for fighting the fire, for the only stream of water that could be brought to bear on the burning ship was from a tugboat, which proved most inadequate. On the following day a fire engine was placed on a barge and towed near the burning ship, and the day afterward an additional hose was secured from another ship in port, and the fire was finally gotten under control, but not, however, until most of the oil had burned and the vessel badly damaged.

Booms were slung across the bayou to prevent the burning oil, which was floating on the water, from spreading to the shipping and docks near by. The dock to which the vessel was moored was completely destroyed.

The *City of Everett* was built in 1895, at Everett, Wash., for the Standard Oil Company, and is of the whaleback type, 348 feet long, 42 feet beam, and 26 feet 7 inches deep, with a gross tonnage of 2,504 tons.

French Warships.—The French naval pragramme for 1904 calls for the construction of 70 vessels, including 50 torpedo boats, 16 submarines, 1 armored cruiser, and 3 torpedo-boat destroyers.

Seagoing Torpedo-boat Destroyers.—The first of the 25 1-2-knot seagoing, English torpedo-boat destroyers, building by the Palmer Shipbuilding Company, Yarrow, England, have been launched and are now undergoing preliminary trials. These vessels are 225 feet long, 23 feet 6 inches beam, and have engines of 7,000 I. H. P. These boats are somewhat heavier throughout than the former type, yet, because of the contract trial conditions, the decrease in speed is not as much as apparent.

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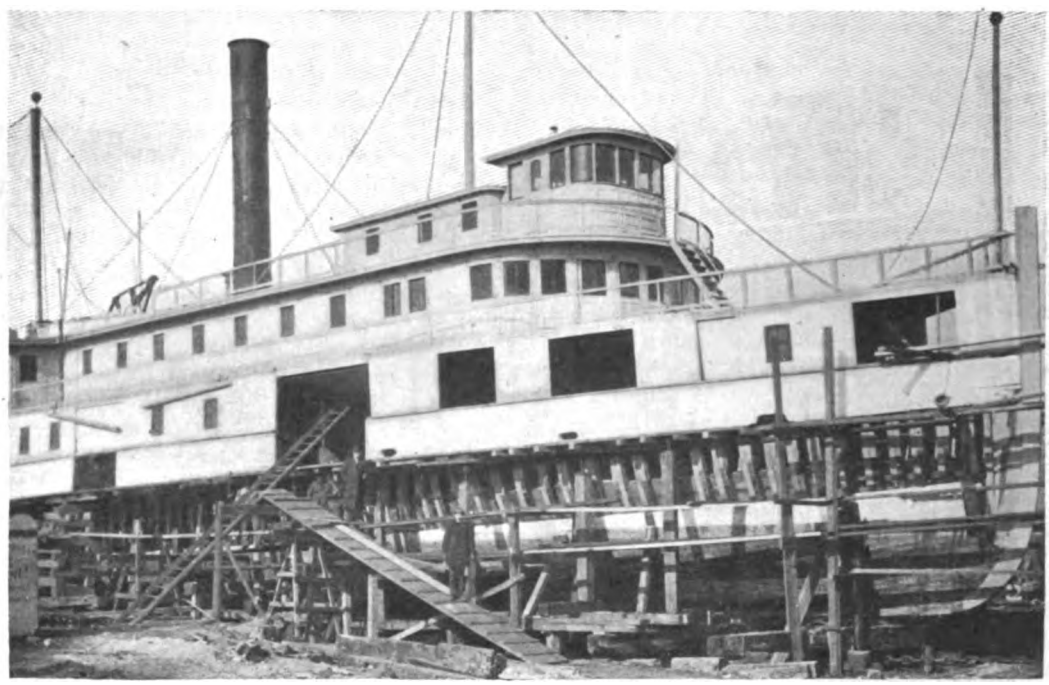
An Interesting Naval Operation.

Editor Marine Engineering:

Lengthening a ship is now quite an ordinary feat in ship-repair work, although nevertheless the operation is a difficult one. When a ship does not trim as she should, or, more especially, when it has been decided to increase her carrying capacity, the vessel is placed in dry-dock, cut in two in the middle, and one end drawn from the other; the intervening space being built up with frames and plates the same as the rest of the structure of the vessel. The steamer *Indian*, of the Boston and Philadelphia Steamship Line, was successfully lengthened 40 feet at the yard of Harlan and Hollingsworth Company, Wilmington, Del. The ship was originally 227 feet long, 38 feet beam, with a gross tonnage of 1,576 tons. The illustration was taken directly after the boat had been severed and drawn apart from the rest of the hull.



STEAMBOAT ULSTER, INCREASED IN DEPTH.

It remained, however, for the Saugerties and New York Steamboat Company to undertake a new departure in increasing the efficiency of one of their boats, the *Ulster*. This vessel is 205 feet long by 30 feet beam, and of 690 gross tons. She is propelled by a walking-beam engine with a cylinder 42 inches diameter by 9 feet stroke. Her speed was not up to the standard of the rest of the fleet, and, when heavily loaded, her freeboard was entirely too small. To overcome this serious difficulty it was determined to increase the depth of the boat by adding on two feet. This was done by cutting the upper part of the ship, just above the guard, entirely away from the lower part. This took place while the vessel was in one of the dry-docks at Erie Basin, South Brooklyn, N. Y. After this had been carefully done, seventy-three screws were distributed at as many different points; forty-eight were placed in the outside, in a double row, under the guards, to carry up and support the overhang. The remaining twenty-five were placed inside the hull of the boat, in a double row amidships, port and starboard of the boilers and engines, and in a single row fore and aft. The screws used were the regular lifting or jack screws, with holes in the top in which a bar could be inserted to make the necessary turns.

The manner of holding up the ship was as follows: In the hold were three built-up piles of good, strong wood with the blocks laid crosswise; on the outside, under the guards, were nine piles similarly constructed. These supports are called cribbings, and are placed at regular intervals; the part they play in the operation being that of steadying the deck structure. Twelve of the screws were placed on these cribbings. In between these solid square cribbings were placed the other sixty-one screws, set in upright posts hollowed out at the top, called "pumps." They were so arranged as to carry practically as much of the weight as the other screws. From practice, as well as theory, the lifting power of each had been determined upon as five tons.

The upper part of the ship was lifted away from the lower part in this fashion: Workmen were placed at every third screw; when the signal to start was given, the men, moving and working as nearly automatically as possible, passed from screw to screw, giving each one, as they passed it, a quarter of a turn. This lifted the boat up about one-fifth of an inch; this was kept up until the limit to which the screws could be raised was reached, when there was a space of about six or eight inches between the ship and the cribbings. Two blocks, laid crosswise, were placed in this space. By driving wedges between these blocks the ship was raised several inches. This was necessary in order to admit of taking out the screws, putting new blocking under

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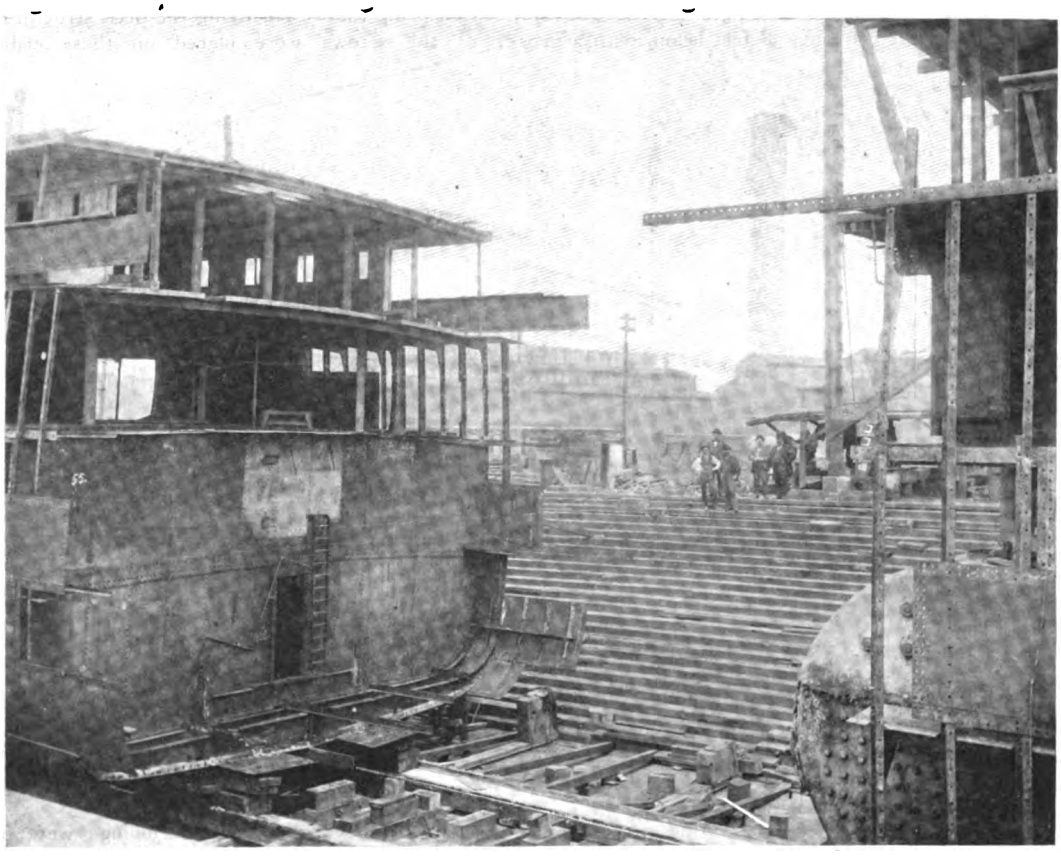
them, and so raise them up. When the "pumps" were removed, shores were used temporarily until longer "pumps," into which the screws were fixed, could replace them. In case longer "pumps" were not at hand, blocks were placed under the original ones. The jacking-up process was again started, the men working as before. This operation had to be continued until the desired space—24 inches—was obtained.

The operation was in every way a decided success. There were no joints sprung, nor were the decks strained in the least. After the desired depth had been obtained, every frame was spliced where it had been cut. The stem and stern were also spliced. The gap made in the hull was then covered over, and, after several coats of paint had been applied, the vessel was again ready for service.

Her speed was considerably increased, due to the fact that the wheels were not submerged as deeply as before, and her greater freeboard gave an increased carrying capacity. Thus was demonstrated practically the success of this curious and enterprising operation.

JOSEPH C. WILSON.



STEAMER INDIAN, CUT IN HALF FOR LENGTHENING.

PERSONALS.

Richard L. Newman, late of the Globe Iron Works and the New York Shipbuilding Company, wishes to state that the dummy president of the United States Shipbuilding Company, reported in the papers to be a Mr. Newman, is not to be confused with Mr. R. L. Newman.

John Calder has resigned the position of executive engineer with the C. W. Hunt Company, New York, to become general manager of the Remington typewriter factories at Ilion, N. Y.

Rear-Admiral Francis T. Bowles, Chief Constructor of the Navy, has resigned his position to accept the presidency of the Fore River Ship and Engine Company. Mr. Bowles has been Chief Constructor of the Navy for the last two years and when appointed was the youngest of the rear-admirals. The former president, Thomas A. Watson, has become chairman of the board of directors. There are three United States battleships, the *Rhode Island, New Jersey,* and *Vermont,* and the protected cruiser *Des Moines,* building at this yard.

Washington L. Capps has been appointed Chief Constructor of the Navy to fill the vacancy created by the resignation of Mr. Francis T. Bowles. Mr. Capps has been constructor in charge at the New York navy yard.

Eads Johnson, formerly the New York agent for B. B. Crowninshield, is superintending constructor to the Lighthouse Department at Staten Island, New York.

Charles A. Wheeler, formerly inspector of steel for Revenue Cutter Service, Pittsburg, Pa., is now assistant engineer on the U. S. S. *Algonquin,* New London, Conn.

J. Cameron has lately left the Moran Brothers and gone to the hull drafting room of the Union Iron Works to take charge of the sugar steam schooner *Likelike,* building for the Wilder's Steamship Company, Ltd.

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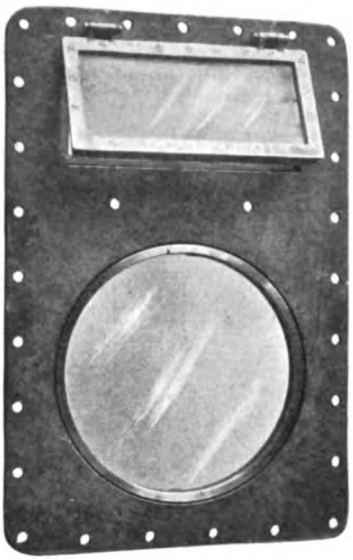
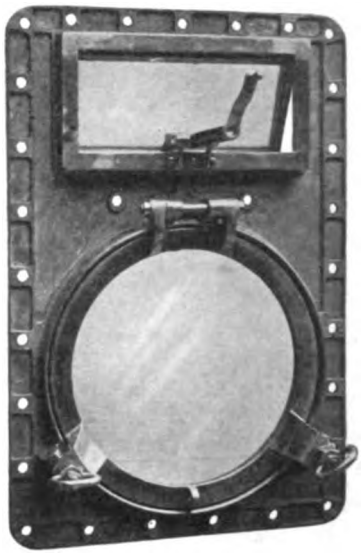
ENGINEERING SPECIALTIES.

Large-Sized Air Ports.

The cuts below show the inside and outside views of a side light furnished for the steamships *Mongolia* and *Manchuria*, the 615-foot vessels now being completed at the yard of the New York Shipbuilding Company, Camden, N. J., for the Pacific Mail Steamship Company, New York. These lights, 102 of which will be installed in each of the above vessels, are of a very excellent type, both in regard to appearance and construction.





INSIDE AND OUTSIDE VIEWS OF LARGE SIDE LIGHT.

The upper portion, the glass of which is chipped to a neat design, acts as a ventilator, and has for this purpose a screw gear. The lower light is a 15-inch, hinged light, with a clear opening of 16 7-16 inches.

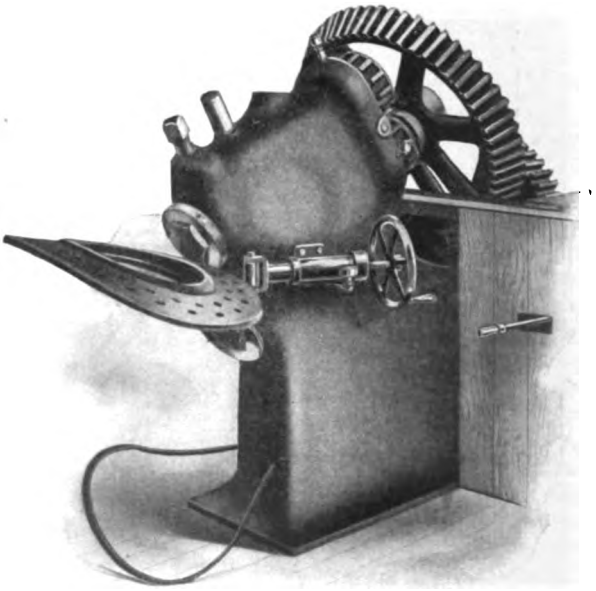
These lights are constructed for heavy sea service, and at the same time are made as light as is consistent with strength from the point of economy, all unnecessary material being cored out. The material used is yellow brass, and all the parts visible from the inside are highly polished.

The contract for these lights, together with 92 hinged square lights intended for the same vessels and 22 fifteen-inch hinged round lights, comprising in all 318 lights, with an aggregate weight of 33,240 pounds and being composed of 18,415 distinct pieces, was given to the Delaware Marine Supply Manufacturing Company, of Wilmington, Del., who made the metal patterns and furnished the lights complete.

Radial Bevel Shear.

The Lenox rotary bevel shear here illustrated presents many novel features, performing such work as has heretofore taken a great amount of hand labor, or else, if the bevel is to be well finished, has required placing of the piece on a planer, thereby making the work expensive in time and labor. The Lenox machine is made for cutting steel of any thickness from 1-8 to 3-4 of an inch, on a bevel. The work is done by rotary blades which revolve in opposite directions, beveling and feeding the plate while they cut it. The machine is built in two sizes; for cutting plates up to 1-4 inch requires 3 horse power, and the larger size, for cutting up to 3-4 inch, requires 8 horse power.

The shear works equally well on straight or curved sheets, and, as is shown in the cut, can be used for beveling such unhandy and irregular shapes as a man-hole saddle, and gives a clean, even finish. Other special uses for this machine are for beveling furnace flanges on boiler headers, straight and curved edges of a boiler dome sheet, beveling angles, etc.



ROTARY BEVEL SHEAR.

The plates are made from high-grade tool steel and

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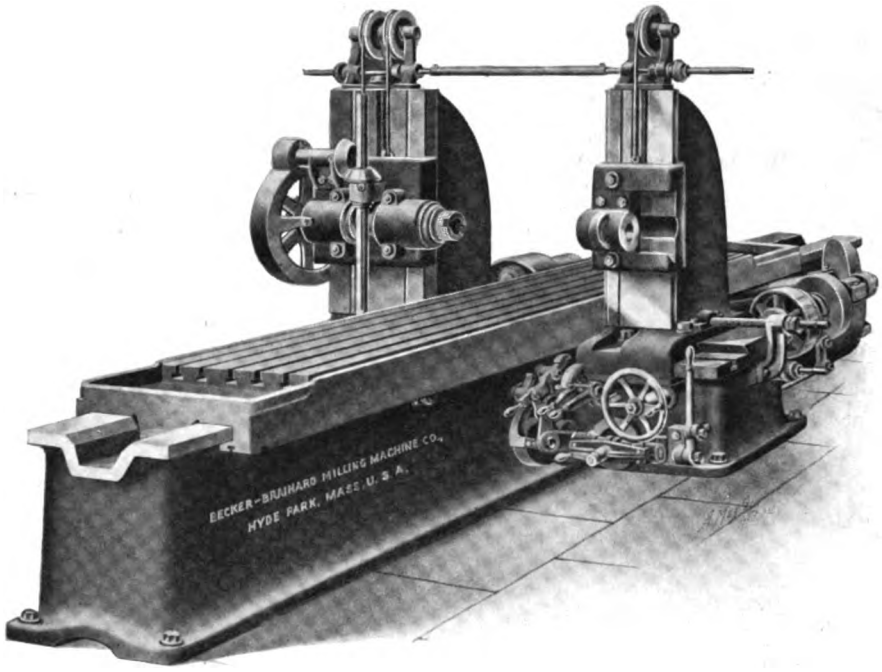
carefully turned and milled, thus making them self-feeding; the upper plate is double-edged, so in case of damage to one cutting edge it may be quickly reversed and the opposite edge used. The plates will not receive a plate that is too thick, nor admit of a prying-off strand.

A special type of machine, called a splitting shear, built on the same principle, is capable of working four or five hundred feet of plate in an hour, the speed being limited to the ability of the operator. The shear is sold by Joseph T. Ryerson and Company, Chicago.

ratios of 13 1-2 and 27 to 1 by 5-inch belt on a 5-step cone, the diameter of which is 23 inches on the largest step and 13 inches on the smallest, giving a range of feed through eight changes from 3-64 to 3-8 inches. These changes of feed can be made instantly by means of a lever without stopping the machine.

The head may be adjusted in either from either side of the machine, so that it is not necessary to take the cutters off the arbor in order to change their position in relation to the work. The bed is extra deep, extending to the floor and making a solid foundation. It is



A NEW PLANER-TYPE MILLING MACHINE.

Planer-Type Milling Machine.

The Becker-Brainard Milling Machine Company, Hyde Park, Mass., has recently gotten up new designs for a 32 by 36-inch by 10-foot planer-type milling machine of very heavy construction and power, while, at the same time, special provisions are made for operating the machine with ease and to meet the demands of modern practice. The spindle is of hammered crucible steel, 5 inches in diameter; has a threaded nose, and runs in self-centered bronze boxes, with nut and check nut to compensate for wear. The spindle carrier is very heavy and is held firmly to the upright by long gibs. It is elevated by a screw with adjustable dials graduated to thousandths of an inch, and has a counterbalance for ease of operation. There are 20 changes of speed for the cutter spindle obtained by gearing in the main driving cone, operated by clutch and lever, so that all changes can be made instantly.

The table is very heavy and is regularly built, with five T-slots lengthwise and an oil channel the full length and at each end. It travels on flat ways securely gibbed, and has a quick return operated by power from a separate countershaft. It can also be moved by the usual hand wheel. The feed of the table is directly operated through gearing from the spindle at

securely braced by heavy cross-girders which are evenly spaced throughout the entire length. The bed can be made any length desired. The specifications provide for a machine with the greatest capacity, and the net weight of it is 25,000 pounds.

Recording Thermometer.

The use of the thermometer in engineering is daily assuming a more permanent place. As an indicator of temperature conditions it is the greatest service to the engineer. Following closely the simple thermometer, the recording thermometer has been extensively introduced for cold-storage compartments, besides for use in recording the temperatures of the air of engine room or cabin. Here is given an indisputable testimony of temperature.

In the form of a thermometer, here illustrated, advantage is taken of the well-known principle of differential expansion by heat in a metallic strip made of two or more metals and the consequent distortion of the strip or lamina. In the recording thermometer the bimetallic strip or lamina is in the form of a helix; one end is fast and the other end carries the pen over the recording sheet. The recording sheet is ruled into 120 spaces and is carried by a high quality eight-day

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escapement clock. The zero of the dial can be at any point on or off the scale, and the thermometer can be made to record temperatures up to the point where the heat would stop the clock, between 250 and 300 degrees Fahrenheit. The lamina can be adjusted to either the Fahrenheit, Centigrade, or Réaumur scale.

The general appearance of the instrument is workmanlike and neat; the round case covers the clock and dial; the glass front opens on a hinge shown at the right of the cut and is latched by the thumbscrew shown at the left. It can be locked by passing the staple of a

STANDARD RECORDING THERMOMETER.

padlock through the eyes below the thumbscrew. The clock movement is rigidly attached to the back of the instrument, and the construction of the case is such that dust is prevented access to it.

The protuberance below the case in the cut shows the lamina cover; this is perforated in order to get as great sensitiveness of operation as possible—it is so sensitive that it records a breath. There are eyes for screwing or fastening it to a wall. The pen is made of a hard nickel alloy, and is readily set, if it gets out of position, by means of a setting screw at the lamina holder.

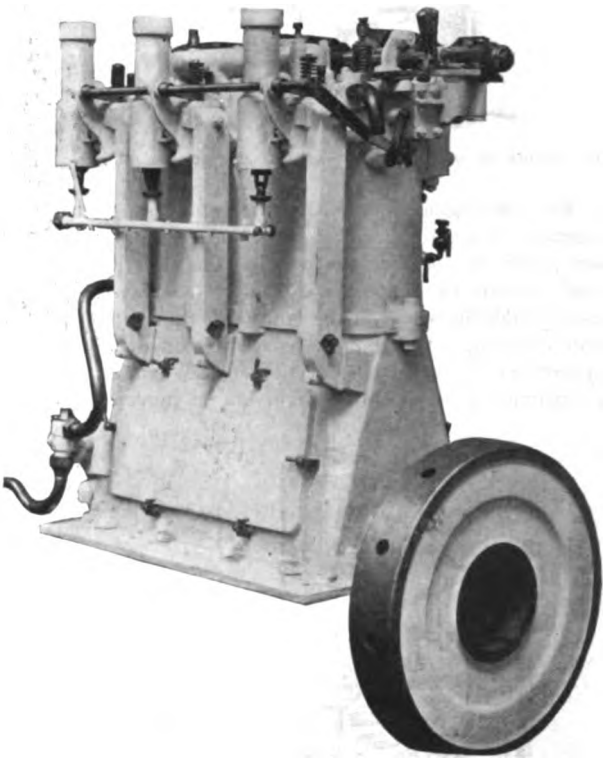
These thermometers are made by the Helios-Upton Company, Peabody, Mass.

Bertheau Reversible Oil Engines.

The most important novelty about the Bertheau oil engine, and that which specially recommends it for marine purposes, is that it is reversible; that is to say, the engine itself runs either way, and so can be connected rigidly to a screw propeller or other shafting without the complication of reversing clutches. This is effected by means of a double set of cams, which can be shifted by simply moving a reversing lever, as in the case of a steam engine. The engine has three cylinders, so that there are no dead points, and it can therefore be started, stopped, and reversed instantaneously.

These engines are also fitted with a reservoir containing burnt gases at a pressure of about 100 pounds per square inch, for purposes of starting and maneuvering, and these are filled with burnt gases from the cylinder; the gases being admitted by means of a relief valve arranged to open at a pressure slightly below that of explosion. The reservoir is replenished by letting burnt gases enter for a few revolutions after starting, and then is shut off.

The oil used in these engines is heavy petroleum; that is to say, it has a specific gravity from .82 up-



THREE-CYLINDER REVERSIBLE OIL ENGINE.

ward, with a flash point of 86 degrees Fahrenheit and above. The consumption of oil is about 1 pound per brake horse power per hour.

The engines are made in the following stock sizes:

B H P.	Revolutions per Minute.	Weight, including Automatic Starting Reservoir.
4	600 (about)	4 cwt.
10	500	11 1-2 "
15	325	25 "
30	275	40 "

The weights given (which include reservoirs) are subject to slight modification, as they are somewhat dependent on the convenient disposition of the reservoirs. The 4 brake horse power has only one reservoir. The engine is made by John I. Thornycroft and Company, Limited, Chiswick, London, England.

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Lippincott Specialties.

The annexed engravings represent a line of Lippincott's patented indicators, reducing wheels, and planimeters. Fig. 1 is a section view of the engine indicator and is almost self-explanatory. The radical difference between this instrument and others consisting more particularly of the frictionless piston and swivel elbow, the

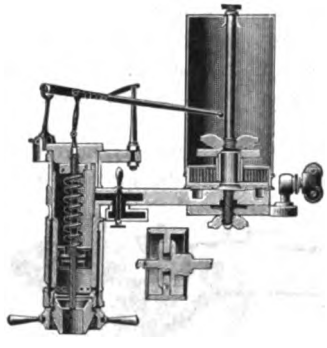

FIG. 1.—SECTION OF PATENT INDICATOR WITH FRICTIONLESS PISTON.

latter for discharging the exhaust steam away from the operator, no matter what his position. The frictionless piston has reduced the friction to almost nothing, and consists of a piston rod elongated sufficiently to pass through the spider at the bottom of the cylinder, to form a bearing at the bottom as well as on the top. The piston web is carried between the steel flanges in such a manner as to permit a slight lateral movement,

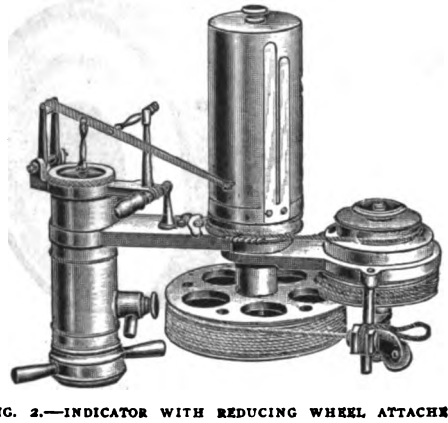

FIG. 2.—INDICATOR WITH REDUCING WHEEL ATTACHED.

so that no matter how much the piston rod may be bent, no pressure can exist between the piston and the cylinder, and, therefore, no friction.

Fig. 2 shows the Lippincott "Peerless" reducing wheel, patented, attached to an indicator, and this wheel is so constructed as to permit of attachment to any make of indicator, and will operate successfully at any speed up to 500 and on any stroke up to six feet, and is made in a larger size for strokes up to eight feet.

The Improved Lippincott planimeter, Fig. 3, is provided with two triangular scales, each having six graduations, or twelve in all, the instrument being capable of giving a reading from the pointer over the scales, the mean effective pressure of any indicator diagram without computation, or by setting according to instructions, a reading may be had in square inches and tenths. These instruments are made by the Scranton Steam Pump Company, Albright avenue, Scranton, Pa., from whom full particulars may be obtained.

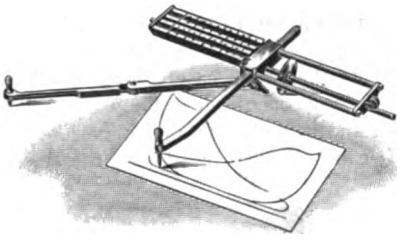

FIG. 3.—PATENT PLANIMETER.

LAUNCHES.

Austrian Battleship Archduke Karl.—On October 4 there was launched from the works of the Stabilimento Tecnico, Trieste, the first-class battleship *Archduke Karl.* The hull and machinery were the design of the builders. The ship is of a new type and will be the largest battleship in the Austrian service. Her dimensions are as follows: length between perpendiculars, 390 feet; breadth, extreme, 71 feet 6 inches; draft, mean, with all weights on board, 24 feet 6 inches; displacement with all weights on board, 10,600 tons. The vessel is fitted with two masts with the usual signal yards, the foremast being also fitted with military top. Practically all the material used in the construction has been supplied by Austrian and Hungarian steel makers; while the armor, of which there is close on 3,000 tons, is being supplied by Witkowitz, and is of nickel chrome steel treated by the cementation process. The hull is constructed of Siemens-Martin steel, and the design is generally in accordance with the most modern practice for vessels of this type, the subdivision of the vessel into water-tight compartments being such as to assure sufficient buoyancy and stability under all probable conditions of damage; the double bottom, which extends for a length of 255 feet, being minutely subdivided. Deep bilge rolling keels are fitted on either side for about half the vessel's length amidships. The armor belt, which is 8 feet 9 inches deep by 8 1-4 inches thick, extends for a length of over 250 feet amidships, the lower edge being 4 feet 9 inches under water when the vessel is in sea-going condition; above this belt the broadside is protected to the height of the battery deck by armor 4 3-4 inches in thickness; while above this again on the battery deck a citadel encloses 8 of the 19-cm. guns of the secondary battery. An armored protective deck, 3 1-4 inches thick on the sides, is fitted all fore and aft.

The gun equipment consists of four 24-cm. quick-firing guns mounted in pairs in barbettes, one barbette being aft and one forward the barbette armor being 9 1-2 inches thick. These guns, which have a length of 40 calibers, are supplied, as are those of the secondary battery, by the firm of Skodawerke, Pilsen. The forward guns have an arc of training from right ahead to 40 degrees abaft the beam. The muzzle energy of these guns with a 470-pound shot is equal to 6,170 metric tons, capable of penetrating about 16 inches of

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nickel chrome steel, the range at the maximum degree being 10 miles. The training, elevating, loading, and otherwise working of the guns is done by electricity. The secondary battery is composed of twelve 19-cm. quick-firing guns, eight of which are mounted in separate casemates in the before-mentioned citadel on the battery deck, four on each side; while the other four are arranged on the upper deck, two on each side. Four aimed shots per minute can be fired from these 19-cm. guns, the shot being 198 pounds in weight and the muzzle energy 3,315 metric tons, equal to a penetration of 9 inches of hardened-steel armor. Fourteen 7-cm. quick-firing and sixteen machine guns, variously distributed, complete the gun equipment. In addition to the above, the vessel is fitted with two under-water broadside torpedo tubes for 18-inch Whitehead torpedoes. The vessel will be commanded, when in action, from two armored conning towers; these, as is usual, being fitted with the necessary armored communication tubes carried down to the protective deck.

The electric-lighting outfit consists of two steam-driven dynamos, each of 50-Kw. capacity. The lamps necessary for the efficient lighting of the ship are upward of 700 in number, while in addition to these there are seven searchlight projectors, each of 25,000-candle power. The turrets and guns of the 24 and 19-cm. guns are operated by electricity, current being supplied by seven dynamos, so connected that any dynamo may also be used for lighting purposes if necessary. The boats, of which there are fourteen, are swung from two large davit cranes.

The vessel, which is of the twin-screw type, is propelled by means of two four-bladed bronze propellers driven by independent sets of 4-cylinder, vertical-inverted, triple-expansion engines capable of developing 14,000 indicated horse power at 132 revolutions and of giving the vessel a speed of 19 1-4 knots per hour. At an economical speed the vessel will have a radius of action of 4,500 miles, the bunkers having a capacity of 1,315 tons. The cylinders are of the following dimensions: 30, 51, 60, and 60 inches diameter by 39 inches stroke. There are twelve Yarrow boilers for supplying steam to the main and auxiliary engines, the working pressure being 300 pounds. The Howden system of forced draft is used, and there are three boiler rooms with four boilers in each. A distilling apparatus is fitted which is capable of supplying 120 tons of fresh water in twenty-four hours. A very complete installation of auxiliary machinery for all purposes is fitted, there being not less than 87 independent auxiliary machines, with 146 steam cylinders, for the various requirements.

Oil-Tank Barge No. 27.—On September 23 the Standard Oil Company's oil-tank barge No 27 was launched from the Townsend-Downey Shipbuilding Company's yard at Shooter's Island, New York. The barge is 365 feet over all and is provided with 20 oil tanks, varying from 12 to 28 feet long and 33 feet deep, and will be able to carry 1,800,000 gallons of oil. The barge will have five steel masts, one of which will be used as a smokestack. Her sister ship, known as No. 28, is building on adjoining ways.

Steamer Hedwig Menzell.—On September 5 there was launched from the yard of the Flensburg Shipbuilding Company, Flensburg, Germany, the steamer *Hedwig Menzell*, built for the Chinesische Kustenfahrt Gesellschaft. Her principal dimensions are: length over all, 244 feet; breadth, extreme, 35 feet 2 inches; depth, molded, 18 feet 3 inches. She will have triple-expansion engines with cylinders 15, 23 1-2, 43 1-4, and 34 1-2 inches stroke. Steam will be supplied by two boilers 11 feet 2 inches by 9 feet 10 inches in diameter. The carrying capacity of the *Menzell* will be 2,050 tons.

Steamship Missouri.—On August 20 the Atlantic Transport liner *Missouri* was successfully launched at the works of the Maryland Steel Company, Sparrow's Point, Md. The *Missouri* would have been launched last year had not her construction been delayed by fire in October, 1902. Her principal dimensions are: length over all, 505 feet; length between perpendiculars, 490 feet; beam, 58 feet; depth of hold, 43 feet; displacement, load, 17,200 tons; net register, 5,131 tons. Twin screws are driven by triple-expansion engines with cylinders 25, 42 1-2, and 72 inches diameter with stroke of 48 inches, which propel the vessel at a speed of 12 knots. Steam is supplied from two double-end and two single-end Scotch boilers fitted with Howden's system of forced draft. This ship was fully described in Marine Engineering of January, 1903; she will cost complete about $730,000.

Lighthouse Tender Magnolia.—There was recently launched from the Baltimore Dry-Dock Company's yard the lighthouse tender *Magnolia*, especially designed for service on the Gulf. This service requires both a vessel capable of going to sea and also to navigate the shallow waters of some of the Gulf ports. She is fitted with two tanks which when filled with water will give a maximum draft of 9 feet, while when emptied the tender draws but 6 feet 6 inches. The hull is of steel, 173 feet 2 inches long, 30 feet 3 inches beam, and 13 feet 1 inch depth molded, and displaces, at 9 feet draft, 550 tons. She is propelled by twin screws driven by compound engines with cylinders 18 and 34 inches by 24 inches stroke. Two Scotch boilers will supply steam at a working pressure of 120 pounds. The vessel is schooner-rigged and thoroughly equipped for handling buoys and carrying supplies to the lighthouses.

Car Ferry Père Marquette 19.—Another large ferryboat for the Père Marquette Railway Company was launched on October 17 from the Cleveland yard of the American Shipbuilding Company and christened the *Père Marquette 19*. The new steamer has no passenger accommodations, but in other respects is a duplicate of *Père Marquette 17*, turned out from the same yard. She is 350 feet over all, 338 feet keel, 56 feet beam, and 36 feet deep. She is driven by two sets of triple-expansion engines with cylinders 19, 31, and 52 inches by 36 inches stroke. Steam is furnished by four Scotch boilers 13 feet 9 inches diameter by 12 feet long. She will be operated between Ludington, Manitowoc, and Milwaukee on Lake Michigan, and will carry 30 loaded cars at a speed of 16 miles. The cars are run on board the main deck at the after end. The new boat will cost about $400,000. A sister ship, to be named *Père Marquette 20*, is building at the same yard, and after launching will be towed to Chicago for fitting out.

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QUERIES AND ANSWERS.

Q. 165.—Please advise me how to calculate the necessary horse power of a centrifugal pump dredge, especially like that described in the June number of MARINE ENGINEERING. Also, please advise how to find the equivalent total head pumped against.

A.—In order to calculate the horse power in a dredge pump it is necessary to have the following items:

1. Quantity and kind of material to be dredged.
2. The length of pipe through which this material is to be carried.
3. The diameter of the discharge pipe.
4. The velocity of the flow of liquid, which depends upon the weight of the material to be carried through the pipe.

The quantity of material in cubic feet discharged per minute, multiplied by the weight of said material per cubic foot, times the total head, divided by 33,000, gives the horse power. The horse power multiplied by the efficiency would give the I. H. P., and to this about 15 or 30 per cent. should be added for the maximum power.

The equivalent total head pumped against is obtained more from special conditions of each individual problem than from formulas, and is governed by the following conditions:

(a) The frictional head per total length of pipe, which depends upon the size, thickness, and arrangement of the pipe.

(b) The velocity.

(c) The suction head.

(d) The elevation to which the material is lifted.

Considering the discharge as a fluid, the friction and velocity heads may be found by referring to formulas in hydraulics.

Q. 175.—I have a 40 by 5-foot speed launch with two 10-horse-power, double-cylinder, four-cycle gasoline engines with right and left propellers. Kindly inform me which would be the proper way to have the propellers turn—that is, what I mean, either to have them turn out or in. H. C. D.

A.—The more common arrangement is for the shafts to turn outboard; that is, for the starboard propeller to turn right-hand and the port propeller left-hand, when standing at the stern and looking forward. The inverse arrangement has been tried with no apparent effect on the propulsive efficiency, so that if you have any particular reason for preferring one rather than the other, so far as your engines are concerned, it would probably make no difference and you might choose in accordance with such reasons. If, however, no such special reasons exist you would find it more in accord with the usual practice to fit them to turn outboard, as noted above.

Q. 176.—Please decide the following: At a recent examination the following question was asked:

If your pump was *in perfect condition*, and after having run for some time you saw it was not feeding the boiler, what would be the cause?

Applicant claimed, if in perfect condition, it would feed the boiler or stop—if the joints, etc., held out.

Examiner claimed the check would be fast on the seat and the pump keep running.

Conditions: Water above suction side of pump; steam from boiler direct to pump, 100 pressure per square inch, feeding against same pressure. Steam pipe, etc., as called for. Pump 6 by 4 by 8, double-acting, check valve hinge. Stop valve between it and boiler. Everything clear to boiler shut down three hours. T. R.

A.—This is largely a matter of the definition of terms and as to what is meant by perfect condition. A pump might be in perfect condition throughout and might be run without delivering any water, simply because it was getting none to deliver. Suppose the suction were dry or clogged, or shut by a valve; then while the pump would run it would feed no water. In any such case, however, it would be instantly clear to any one in the least familiar with pumping machinery that the pump was not handling water. The operation of a pump when pulling against a closed suction and when handling water under normal conditions is so different that no one accustomed to such matters would be long in doubt as to the condition in question. In the case supposed, it is stated that the water on the suction side is above the pump. If, then, the suction is open and the pump is in perfect condition and is operating, it will mean that it is handling water and that, in consequence, the water is going into the delivery pipe. If it is going in it must be going out, and either through the check valve into the boiler or elsewhere. Thus there might be a branch pipe leading from the feed pipe with valve partly open; or, again, there might be a split in the pipe and the water might be leaking into the bilge. If the check valve is closed and no other way of escape exists for the water, the pump will obviously either stop or burst the pipe or connections on the delivery side. It is readily seen from the above brief discussion that it is very necessary to exactly specify all the possible conditions which may affect the problem, and the answer is then usually simple and beyond question. Without such exact specification various probabilities may exist, and there may be abundant room for various differences of opinion.

In the present case it seems to be assumed that the pump is handling water, and if so it is not clear how it could continue running with check valve fast on seat, unless there was some other way of delivery or escape, such as a branch pipe or leak, as noted above.

Q. 177.—I wish to use a special form of rubber washer, as illustrated below, but do not know whether it will stand the service to which it is to be subjected. The ranges of temperature will be from 32 degrees to 100 degrees Fahrenheit. It is used as a cushion between *P* and *R*. *P* is a rigid piece of metal, with guide, *Q*, through which passes metal *R*, which vibrates backward and forward with relation to *P* in direction *AA* at rate of 2,000 per minute.

Through *R* is an air passage, and *W* is a rubber washer, which is supposed to take up the vibration of *R* so that it will not be communicated to *P*. The weight of *R* also falls upon *P*, or, that is, upon the rubber, and thence upon *P*, and is perhaps 15 to 20 pounds. A. J. C.

A.—The surest way of settling a question of this character is, of course, to try the experiment. So far, however, as experience indicates, good rubber should stand the range of temperature which you specify, with but slow deterioration and loss of elastic properties. All vulcanized rubber, under atmospheric influence, gradually stiffens, becomes brittle, and loses its elasticity. This will, of course, take place in time, with such use as you wish to put the washer to. If, however, the air flowing through the tube is dry and free from oil, as well as the general surroundings of the washer, it

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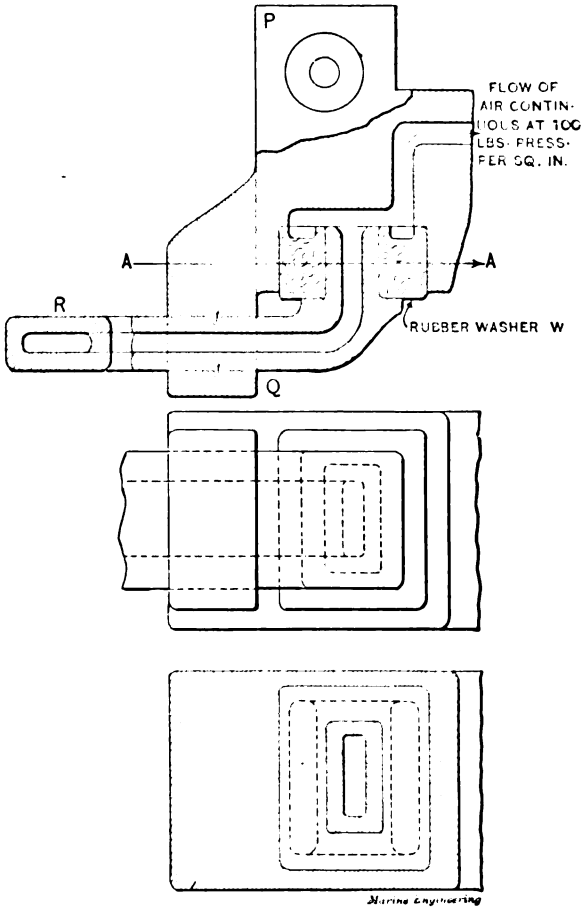
may be fairly expected that the washer will render good service under a temperature not exceeding 100 degrees F., and that it will only require renewal at relatively long intervals. In other words, there would appear no reason why a rubber washer, protected from moisture and



especially from oil, should not render all the service which might be fairly expected from such a device, so long as the temperature does not materially exceed the limits specified.

Q. 178.—Will you please advise me which are the ten leading ports of the world, giving the approximate tonnage of shipping of each port? Also, is Liverpool as progressive as the other great ports? R. W.

A.—Through the courtesy of the Bureau of Statistics, Department of Commerce and Labor, we present the following table, which shows the relative rank in tonnage movement of vessels at the principal ports of the world. Owing to the fact that the coastwise tonnage for the port of New York is not available, the figures of tonnage in the table are for foreign commerce alone.

	Year.	Entered.	Cleared.
London	1902	10,179,023	7,385,085
New York	"	8,982,767	8,415,291
Antwerp	"	8,373,528	8,347,483
Hamburg	"	7,860,323	7,993,166
Hongkong *(a)*	1901	7,383,683	7,340,586
Liverpool	1902	6,843,200	6,314,514
Cardiff	"	4,688,088	7,868,556
Rotterdam	"	5,950,445	5,733,763
Singapore *(b)*	1901	5,459,032	5,453,999
Marseilles	1902	4,911,784	4,552,088
Tyne Ports	"	3,615,046	4,754,301
Gibraltar	1901	4,171,350	4,159,272

(a) Exclusive of Chinese junks engaged in the foreign trade. The tonnage of these vessels entered and cleared was 1,126,931 and 1,130,279, respectively, in 1901.

(b) Exclusive of warships, transports, native craft, and vessels under 50 tons, but inclusive of vessels engaged in trade between the settlements.

Concerning the progressiveness of Liverpool, we would suggest that you write to the U. S. consul stationed there. Large improvements have been made in the docking facilities of that port.

Q. 179.—Will you kindly advise me, through the Queries and Answers column of your MARINE ENGINEERING, dimensions and horse power complete of a trunk-cabin, cruising gasoline launch, 40 feet long, and the highest speed reasonably attained. Would like a speed of 18 knots, if possible.

The boat to be sea-going, capable of going through a "blow-hard," and to take care of four persons on a cruise.

W. W. WARD.

A.—A full answer to this query would require a complete design of the boat, and this we can scarcely undertake to furnish. You should rather apply to some of the leading builders of such craft.

In a general way it may be said, however, that you impose an almost impracticable schedule of conditions. A motor boat 40 feet in length may by special design and powering be driven up to a speed of 18 knots, but in such case the conditions would scarcely admit of a cruising, sea-going design capable of weathering a "blow-hard." If the latter conditions are the more important, then a good, comfortable boat, some 7 feet beam, 10 to 12 tons displacement, and with good freeboard and sufficient power for a 10 or 12 knot speed, is all that should be undertaken. For a boat of this type and for this speed some 30 to 40 horse power would be required.

If, on the other hand, a speed of 18 knots is requisite, the design must be along entirely different lines. The beam could not exceed some 4 1-2 feet, and in every way the lightest type of construction would be required. The displacement would be somewhere about 5 tons with 60 to 80 horse power. Such a craft would be of small value for cruising purposes, and you would be very much better advised to be content with moderate speed and with good sea-going and cruising qualities.

Q. 180.—Can you give me a rule or formula for computing the necessary heating surface in a boiler for a given H. P. cylinder under the following conditions? The diameter of the cylinder is known and the point of cut-off is assumed to be so many inches of the stroke. Likewise the revolutions are assumed to be a certain number. From the three factors given, this particular cylinder will use so many cubic inches of steam per minute. Now, in compound-condensing marine practice, in power ranging from, say, 100 to 250 H. P. (boilers having natural draft only), with steam pressures from 125 to 175 pounds, what number of square feet of heating surface should be allowed for each cubic inch of steam used for fairly good, economical practice?

With most of the auxiliaries being independently steam-driven, say independent circulator, air pump, and boiler-feed pumps, about what per cent. additional H. S. should be allowed? This problem is usually treated in the books by computing the horse power which the engine develops; but one of the first and important factors a student meets is that vagary M. E. P., and to him who has had scant previous experience on which to proportion and build by comparison, it is unsatisfactory. A. H. C.

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A.—Your question states the problem of design in somewhat different terms from those usually employed. If M. E. P. is a "vagary," so also is the number of cubic inches of steam used in the high-pressure cylinder up to the point of cut-off, for, due to initial condensation, it will be far more than the mere volume of the cylinder up to that point. Rarely would the amount thus condensed be less than 15 to 25 per cent. of the amount admitted, so that the actual weight of steam required will be considerably in excess of that occupying the actual volume up to the point of cut-off. This is as difficult to estimate as the mysterious M. E. P.; so that, after all, it comes back to the test of actual experience.

Suppose that we assume moderate draft, burning 16 to 18 pounds of coal per square foot of grate, and evaporating, say, 9 pounds of water per pound of coal, and with a ratio of heating surface to grate of 30 to 35, and hence of coal to heating surface of about .5 and water to heating surface about 4.5. Let n denote the revolutions of the engine. Then experience indicates that under such conditions we should give to the boiler from $n \div 130$ to $n \div 160$ square feet of heating surface for each cubic inch of H. P. cylinder volume up to the point of cut-off. It should be noted that such proportion is intended to apply to steam pressures of 140 to 170 and to a ratio of L. P. diameter to H. P. diameter of about 2 to 1.

Thus, for illustration, suppose H. P. diameter equals 10 inches, stroke equals 14 inches, and revolutions equal 200, with cut-off at 60 per cent. Then volume of cylinder up to point of cut-off equals 660 cubic inches nearly. Taking $n \div 150$ as a fair figure per cubic inch, we have $200 \div 150 = 1.33$ square feet per cubic inch, and $1.33 \times 660 = 880$ square feet of boiler heating surface required.

Where most of the auxiliaries are used independently it will be well to add about 10 per cent. to the heating surface considered adequate for the main engine. In the present case this would give 88 square feet to be added, giving a total heating surface of $880 + 88 = 968$.

If we could have assumed a somewhat more lively rate of combustion, say 22 pounds of coal per square foot of grate surface, we could decrease the heating surface to the neighborhood of $n \div 200$ per cubic inch of cylinder volume up to the point of cut-off. In the present case this would reduce the amount to 1 square foot per cubic inch, and hence to a value of 660 square feet for the main engine and 66 for the auxiliaries, and hence to a total of 726 for the boiler as a whole.

Q. 183.—How would you calculate the thickness of the shell of a cylindrical boiler for a given diameter and pressure, say 6 feet diameter and 200 pounds pressure? Give formula for same. Give formula for finding diameter and spacing of rivets for the longitudinal seam. L. W. V.

A.—The information you ask for is all contained in the general Rules and Regulations of the Board of Supervising Inspectors of Steamboats, copy of which may be obtained gratis by applying to your local inspector or to the Supervising Inspector-General, Steamboat Inspection Service, Department of Commerce and Labor, Washington, D. C.

The formula for finding the thickness of shell is as follows: Let T = thickness of plate in inches; S = tensile strength; P = pounds per square inch gauge pressure: r = radius, or 1-2 diameter, of boiler, in inches. Then

$$P = \frac{\frac{S}{6} \times T}{r} \quad \text{or} \quad T = \frac{6Pr}{S}.$$

Assuming the tensile strength at 60,000 pounds and the values of P and r you have given, we find the value of T as follows:

$$T = \frac{6 \times 200 \times 36}{60{,}000} = .72 \text{ ins.}$$

which is for single riveting. If double riveting is used the pressure may be increased 20 per cent., or the thickness may be reduced to an amount equal to dividing the above value of T by 120 per cent., or .60 inch, say 5-8 inch.

The diameter of steel rivets for steel plates is taken as the thickness of the plate + 3-8 inch. To find the pitch the following formula is used: p = pitch of rivets, in inches; T = thickness of plate, in inches, = 5-8 inch in this case; n = number of rivets per pitch, which is 2 for double riveting; d = diameter of rivet in inches = T + 3-8 inch, or 1 inch.

Then

$$p = \frac{23 \times d^2 \times .7854 \times n}{28 \times T} + d.$$

Substituting,

$$p = \frac{23 \times 1 \times .7854 \times 2}{28 \times \frac{5}{8}} + 1 = 3.064 \text{ ins.}$$

Q. 184.—I have been much interested in the article by Lieutenant H. C. Dinger on "Internal Lubrication of Marine Machinery," and especially that part of it which pertains to the use of graphite. I would like to ask of you and your readers if they know of a method or device for removing graphite from exhaust steam. I am heating water by the direct commingling of exhaust steam, but cannot use graphite (much as I wish I could) for the reason that the graphite will go along with the water and damage or ruin the manufactured stock with which it will come in contact. What effect would graphite have on the inside of boilers where it would be pumped direct from the surface condenser? R. H. H.

A.—We regret that we cannot give you positive information upon this point, and trust our readers who have had experience with graphite will advise us. Refrigerating companies use but little oil, on account of the oil being carried over and staining the ice. In place of the oil a small quantity of graphite is used, with much better results, although now and then a flake of graphite may show as a tiny black speck in the ice. We should imagine that you are using too much graphite. The theory of the use of graphite is that it will attach itself to the cylinder walls and pistons, and but little of it will pass out of the cylinder. As far as we know, no trouble results if graphite is carried into the feed water; in fact, graphite is sometimes used to prevent forming scale, the idea being that graphite will cover the boiler surface with a very thin film to which the scale will not attach itself.

Name Missing.—If our correspondent who writes from Ontario, Ore., on October 14, to inquire concerning a telephone magazine, will please send us his name, which he omitted from the letter, we will communicate with him.

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TECHNICAL PUBLICATIONS.

Governors and Governing Mechanism. By H. R. Hall. Size 5 by 7 inches. Pp. 116, with 76 diagrams and folding plates. The Technical Publishing Company, Manchester, England. Price $1.00.

The purpose of the author in the preparation of this book seems to have been the presentation in a simple form of such matter as will best aid the general student of engineering in his study of governors and governing mechanisms.

The earlier chapters deal, therefore, with general principles and with the simpler forms of such devices, leading up through the various forms of ball or pendulum governor to the many varieties of shaft governor now almost entirely in use on all engines of the high-speed class.

The treatment of the various types and varieties of ball governor with reference to steam-engine practice is especially full, perhaps more so relatively than that of the shaft and inertia governors which for so large a part of the field of modern practice, at least in the United States, have supplanted those of the older ball or conical pendulum type.

Following the discussion of the governor as applied to the steam engine, several of the leading types of gas-engine governors are taken up and discussed with reference to the special conditions to be fulfilled in such mechanisms. Following the subject matter proper of the book is found a numerous collection of illustrations and descriptive matter relating to governors as applied in modern practice to engines of both slide- and drop-valve types, as well as to air compressors, and to the difficult problem of controlling a marine engine under the tendency to race in a seaway.

The descriptive treatment throughout the book is excellent and the general discussion of principles involved is generally clear and sufficiently comprehensive for the purpose in view. Occasionally, as in the discussion of centrifugal force and the conical pendulum in the abstract, there is, perhaps, something to be desired on the score of clearness and cogency of presentation.

The author has rendered to engineers and students a real service by bringing together in a convenient collected form so much information regarding governing mechanisms of various types and for various purposes, and so good a general discussion of the conditions involved and of those to be fulfilled in order that the governor may display in proper combination the various qualities needed to make it effective for the purpose in view. The book may be cordially commended to all interested in this field of engineering practice.

The Slide Rule. By Charles N. Pickworth. Eighth edition. Size 5 by 7 inches. Pp. 104, with 19 figures in the text. New York, D. Van Nostrand and Company. Price 50 cents.

The first edition of this book, published in 1894, has been successively followed by other large editions, showing conclusively the favor with which it has been received throughout the engineering world. To the engineer of the present day the slide rule is almost as much of a practical necessity as the lead pencil. It has assumed a place as an aid in all manner of computations which it is not likely soon to lose, and there has certainly existed a fair field for just such a practical manual as the present work. In the new edition several additions have been made to the contents, particularly in reference to such recent developments of slide-rule methods as are rendered possible by the use of the additional log. log. scales. Slight reference is also given to the use of the slide rule in the solution of certain equations of the second and third degrees. The subject matter as a whole presents first the fundamental principles of the slide rule, and then show its application to the great variety of computations to which it is adapted, including proportion direct and inverse, multiplication, division, finding of powers and roots, and combined operations of various kinds.

Illustrations are then given of the application of the method to various problems in mensuration, mechanics, engineering, trigonometry and surveying, etc. Reference is then made to the various slide rules of spiral, cylindrical, or circular form, and also to the various forms of combination rules for the solution of definite and special problems. The treatment of the subject is clear and eminently practical, and the book should prove a most welcome addition to the working library of every user of the slide rule, and especially to those not well acquainted with its capabilities and who may desire to familiarize themselves with the details of its use and with the wide range of application which the instrument has in the daily life of the practical engineer. To all such we would warmly recommend the book as one most admirably suited to their needs.

Naval Fleets of the World in 1903. By Commandant de Balincourt (French Navy). Size 6 by 4 1-2 inches. Pp. 842, with 403 schematic figures of ships and their armament. Paris, Berger, Levrault and Company. Price 6 francs.

At the present time, when the attention of the whole world is turned with such serious attention to the question of naval strength and armament, and when the rôle of the navy seems likely to become more and more important, compendiums of this character are of the greatest interest and value to every student of naval affairs. The purpose of this book is to present, under a condensed and schematic form, the fullest possible information regarding the warships of all maritime nations. The names of the countries are arranged in alphabetical order, and under each country is given first a brief résumé of the character and tendency of recent construction, with such general observations as the author has deemed appropriate to the case. Then follow on successive left-hand pages schematic sketches of the type ships of the navy under discussion, showing general form, distribution of masts, sail power, if any, with offensive and defensive armament. On the opposite pages are given in each case the names of the ships of that given type with a full statement of their size, power, speed, coal capacity, number and caliber of guns, thickness and distribution of armor, etc., together with such observations or criticisms as may seem appropriate. At the close of the volume is found a complete alphabetical index of all ships mentioned, with nationality and page where described.

The value of such books lies, first, in the quality of the information given, and, second, in the manner in which

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it is presented. The data seem to have been compiled with great care and accuracy, and the character of the information furnished seems, therefore, to be all that could be desired, while its general arrangement and mode of presentation are excellent and enable the leading particulars of any given ship to be ascertained with the minimum expense of labor and time.

For English-speaking readers the book will, of course, be less available than if it were written in English, but the sketches with their indications are clearly independent of the language, and of themselves will be found to give in a graphic manner a vast amount of valuable information regarding the fighting quality of the ships thus indicated.

Railroad Car Charts. Three charts, 27 by 15 inches. Price, each, 25 cents; three for 50 cents. The Derry-Collard Company, 256 Broadway, New York, N. Y.

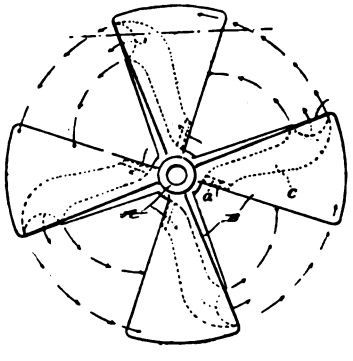
The value of diagrammatic instruction is well recognized, and the preparation of the three charts gives respectively: an anatomy of a box freight car, anatomy of a copper gondola car, anatomy of a passenger car. The publishers have presented large and clear charts of the construction of these different cars. The sections are made in such a way that the construction is clearly shown, each frame, beam, rod, etc., is prepared from diagram, and a key directly below gives the name of the part. They will be found most useful helps to those studying railroading.

SELECTED MARINE PATENTS.

736,951. MARINE PROPULSION. HERMAN H. FOWLER, OAKLAND, CAL.

Claim.—1. A spiral propeller for ships and boats, with hollow shaft to which are attached hollow blades formed by sheets of metal, which, at the shaft, are flanged outward, for fastening thereto, and, at the blade's edge, inward, for fastening together; suspended from the bottom and keel of the vessel, directly under and extending the full length of the keel, provided at the bearings with collars, to serve as thrust rings, and mitered gears by which to operate the propeller. Two claims.

736,952. SCREW PROPELLER. EDWARD FOX, BROOKLYN, N. Y., ASSIGNOR OF ONE-HALF TO WILLIAM LOGAN, ARLINGTON, N. J.



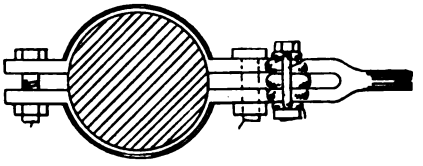
Claim.—1. A screw propeller comprising a hub, and a plurality of blades, pitched at an angle to the longitudinal median line of the hub; each of the said blades being provided with a passage which extends from the forward edge of the blade, with reference to the direction in which the propeller is rotated to drive a vessel forward, at a point adjacent to the hub, and in the direction of the length of the blade across the same, and terminates in a discharge, *b*, formed in the after side of the blade adjacent to the rear edge and outer end of the same, and disposed at an obtuse angle to the intermediate portion of the passage; whereby it is adapted to discharge a stream of water against the rear face of the following blade. Two claims.

737,021. SUBMARINE-CABLE-LAYING DEVICE. BEAUREGARD ROBERTS, MOBILE, ALA. Two claims.

737,078. PLATE FOR SHIPBUILDING. JOHN CHAPMAN, SUNDERLAND, ENGLAND.

Claim.—1. In structures where metal plates are jointed together a plate overlapped on a plurality of its edges by other plates, said overlapped plate being joggled at a plurality of its corners and at a plurality of its edges, so that each overlapping plate is flush with the overlapped plate at points where both the overlapped and overlapping plates are overlapped by a third plate. Four claims.

737,118. FASTENING DEVICE FOR BOOMS. THOMAS S. LAUGHLIN, PORTLAND, ME.

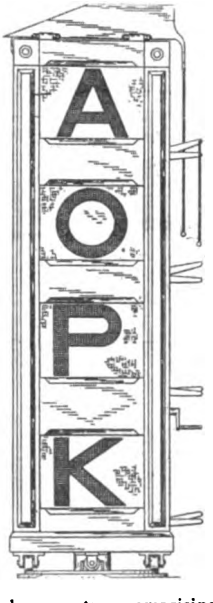


2. The herein-described device for fastening a boom to the mast, comprising a pair of semicircular bands, each provided with oppositely-extending-eyed lugs upon their ends, bolts removably securing said bands around the mast entering said eyes, a bracket mounted upon the forward bolt between the adjacent lugs of the bands and having a downwardly-projecting lug provided with an eye adapted to contact the mast, a screw entering said eye to secure the lug to the mast, said bracket also being provided upon its forward end with a vertical socket, a pintle pivotally mounted within said socket and an eyed lug projecting from the upper end thereof, a screw adapted to enter the end of the boom having eyed portions, a shackle having eyed portions, and a bolt adapted to pass through the eyed lugs of the pintle and the eyed portions of the screw and shackle for securing the shackle and boom carrying the screw to the pintle. Two claims.

737,213. PROPELLING APPARATUS FOR VESSELS. LEON DION, BOSTON, MASS., ASSIGNOR TO AMERICA MARINE COMPANY, NEW YORK, N. Y., A CORPORATION OF SOUTH DAKOTA.

Claim.—1. A vessel having a longitudinal channel in its hull, a drive wheel located in the said channel, having two slotted perimeters separated by an intermediate peripheral space, and a chain composed of a series of units, each including a paddle, and coupling members rigidly affixed thereto, the paddle being formed to engage the slots in the perimeters of the wheel, while the coupling members are formed to enter the spaces between the said perimeters. Five claims.

740,939. MARINE SIGNALING APPARATUS. WILLIAM J. SMITH, SEATTLE, WASH.



Claim.—1. A signal apparatus, comprising a containing case having sight apertures in the front thereof, translucent screens having opaque characters marked thereon, lead rolls for said screens, vertical spindles, spools loosely mounted on said spindles, clutch devices splined to said spindles and adapted to engage the said spools thereto, levers for actuating said clutch devices, worm wheels on said spindles, another spindle arranged transversely to aforesaid spindles and having screws thereon adapted to engage said worm wheels to rotate said first-named spindles, means to rotate the transverse spindle, a brake device substantially as described for each of said spools, lights positioned opposite said case apertures in the rear of the screens, and a reflector. Three claims.

740,946. MARINE PROPULSION. ALBERT J. TAPLIN, WASHINGTON, D. C. Five claims.

741,084. WAVE MOTOR. WILLIAM L. WALTER, PORT HURON, MICH., ASSIGNOR OF ONE-HALF TO MARCIA M. RICHARDSON AND SAMUEL W. SMITH, PONTIAC, MICH. Nine claims.

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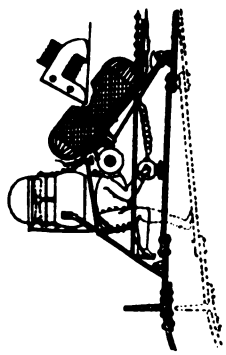
741,227. METHOD OF MAKING ANTI-FOULING COATINGS. GEORGE D. COLEMAN, BOSTON, MASS., ASSIGNOR, BY MESNE ASSIGNMENTS, TO COLEMAN SHIP COPPERING COMPANY, A CORPORATION OF MAINE.

Claim.—1. The method of making anti-fouling coatings for ships' bottoms or structures submerged in or exposed to the action of water, and particularly sea water, which consists in applying to the surface to be coated a layer of quick-drying paint, in projecting particles of finely-divided metallic copper into the surface of this layer of paint while it is still moist, in rubbing or hammering or burnishing the coating to force the particles of copper into the paint to embed them in and envelop them by the paint, in applying still more finely divided metallic copper to the paint which comes to the surface between the particles of copper first applied, and in rubbing or hammering or burnishing the coating to present a smooth surface closely studded with particles of bare metallic copper.

2. The method of making anti-fouling coating for ships' bottoms or structures submerged in or exposed to the action of water and particularly sea water, which consists in applying to the surface to be coated a layer of paint composed of a mixture with cement or paint substance formed of red lead and linseed oil intimately united by baking, of a varnish, in applying to this layer of paint, while still moist, finely-divided metallic copper, in rubbing or hammering or burnishing the surface of the coating to embed the particles of copper in and envelop them by the paint, and to bring the paint to the surface around the particles of copper, in applying still more finely divided metallic copper to the paint so brought to the surface, and in rubbing or hammering or burnishing the surface of the coating to present a smooth surface closely studded with bare particles of finely-divided copper, substantially as described. Two claims.

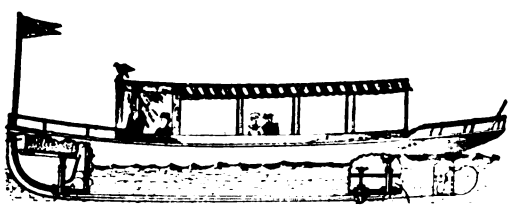
741,228. ANTI-FOULING COATING. GEORGE D. COLEMAN, BOSTON, MASS., ASSIGNOR, BY MESNE ASSIGNMENTS, TO COLEMAN SHIP COPPERING COMPANY, A CORPORATION OF MAINE. Two claims.

741,298. APPARATUS FOR CLEANING AND TREATING SHIPS' HULLS, ETC. HAROLD BINNEY, NEW YORK, N. Y.



Claim.—1. The combination for cleaning or treating ships' hulls, or other objects under water, of an open floating frame forming a seat or support for the diver, with power-actuated mechanism for bringing the same in contact with said hull, and power-actuated mechanism for treating the said hull, and electrical connections from a suitably distant source of current to the said mechanisms. Six claims.

741,512. MARINE VESSEL. CHARLES H. LEE, SOUTHAMPTON, N. Y.



Claim.—1. In a marine vessel, a system for supplying and distributing fuel to an engine, having a fuel pipe located outside of the hull and provided with a branch extending into said hull, and a standpipe open to the water and surrounding said branch of the fuel pipe. Ten claims.

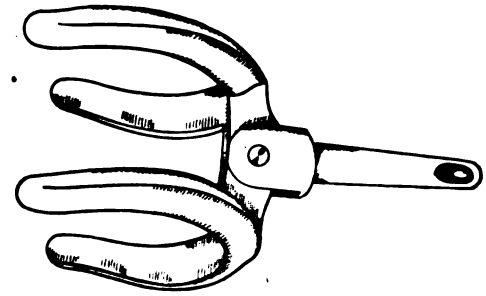
741,683. GYROSCOPIC APPARATUS FOR STEERING TORPEDOES. FRANK M. LEAVITT, BROOKLYN, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA. Three claims.

741,707. LOCOMOTIVE. HENRY E. PARSON, BROOKLYN, N. Y.

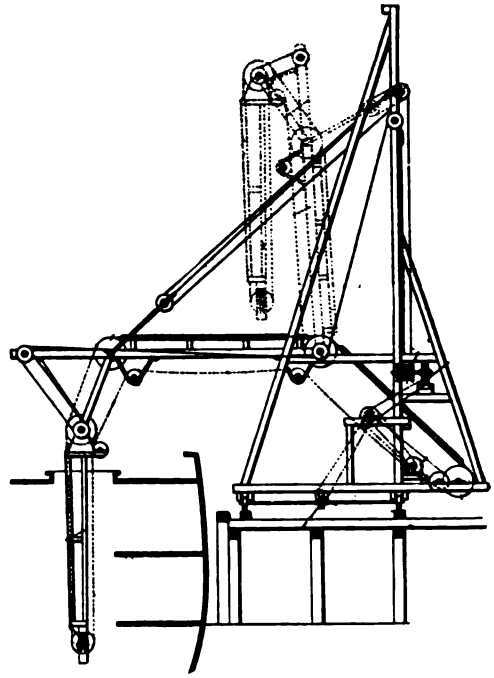
741,769. ANTI-FOULING COATING FOR METAL STRUCTURES. GEORGE D. COLEMAN, BOSTON, MASS., ASSIGNOR, BY MESNE ASSIGNMENTS, TO COLEMAN SHIP COPPERING COMPANY, A CORPORATION OF MAINE.

741,850. ROWLOCK. JOHN R. SUPPLE, OAKLAND, CAL.

Claim.—A rowlock formed with a suitable stem, a cross arm pivoted to said stem and at essentially right angles thereto, a yoke at each extremity of said stem and equidistant from said pivot, said yokes being open at their upper portions to receive the oar. One claim.

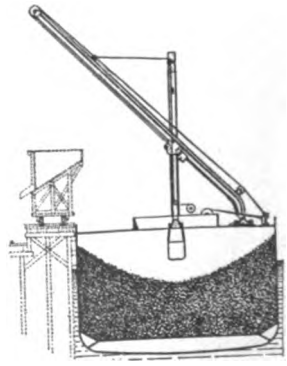


742,023. APPARATUS FOR LOADING OR UNLOADING VESSELS. BEVERLY J. HARRIS, NEW ORLEANS, LA.



Claim.—1. In a loading or unloading apparatus, the combination with a platform, of a frame and a motor mounted on said platform, a swinging frame pivoted to said frame, hanging frames pivotally connected to said swinging frame, idlers mounted in pairs in said frames, dumping idlers mounted near the lower end of the lower hanging frame, and an endless looped apron passing between said idlers. Five claims.

742,101. BARGE. GEORGE E. TITCOMB, PHILADELPHIA, PA., ASSIGNOR TO THE DODGE COAL STORAGE COMPANY, NAUGATUCK, CONN., A CORPORATION OF CONNECTICUT.



Claim.—1. The combination of a vessel, a mast, a rail on the deck of the vessel, a slide adjustable on the rail, a block swiveled in the slide, and a boom pivoted to the block and guyed to the mast, with hoisting mechanism carried by the boom. Four claims.

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